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MOBILE NITRITE WASTEWATER TREATMENT SYSTEM (NWTS) USER DATA PACKAGE

by

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14. ABSTRACT

The Navy uses nitrite solution extensively as a rust preventing fluid in marine boiler maintenance operations. The Naval Facilities Engineering Service Center (NFESC) has developed a chemical reduction process for the treatment of wastewaters containing nitrite in concentrations exceeding water quality standard established by the United States Environmental Protection Agency (EPA).

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SECTION 1

INTRODUCTION

The Navy uses nitrite solution extensively as a rust preventing fluid in marine boiler maintenance operations. The Naval Facilities Engineering Service Center (NFESC) has developed a chemical reduction process for the treatment of wastewaters containing nitrite (NO_2^-) in concentrations exceeding water quality standards established by the United States Environmental Protection Agency (EPA). Through the bench- and pilot-scale testing of the chemical denitrification process (refs 1, 2, and 3), NFESC has performed an economic analysis of the process that indicated that substantial cost savings can be achieved by implementing the new system. The principal advantage of the new system is that the wastewater produced during boiler maintenance can be treated in on-site and directly discharged to the sanitary sewer or to surface waters instead of off-site disposal as a hazardous waste. Based on the previous bench- and pilot-scale testing results, a mobile Nitrite Wastewater Treatment System (NWTS) was designed and successfully evaluated at the Shore Intermediate Maintenance Activity (SIMA) San Diego, California for treating shipboard boiler maintenance wastewater.

The Navy generates sodium nitrite wastewater from four operations conducted during routine, shipboard boiler maintenance. These are: (1) waterjet tube cleaning; (2) boiler lay-up; (3) boiler hydrostatic pressure testing; and (4) rinsing. These maintenance processes generate millions of gallons of wastewater annually. Nitrite can be simply oxidized to nitrate through introduction of oxygen into the wastewater. However, the National Pollution Discharge Elimination System (NPDES) regulates both nitrite and nitrate wastewater discharge to surface waters because both chemicals contribute eutrophication which deprives the water of oxygen. In addition, excessive amounts of nitrate in the water contributes to an illness known as methemoglobinemia in infants (Blue Baby). Current drinking water standards require the maximum contaminant level (MCL) for nitrate and nitrite are 40 mg/L (as NO_3^-) and 3 mg/L (as NO_2^-), respectively.

Wastewaters generated from Navy boiler maintenance activities contain nitrite concentrations sometime up to 1200 mg/L as $NaNO_2$. Typical nitrite concentration for the waterjet cleaning process is 800 mg/L as NO_2^-. The wastewaters also contain various heavy metals in ionic form, including cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), nickel (Ni), and zinc (Zn) which are regulated by the EPA.

After the boiler maintenance operation is complete, the processed sodium nitrite wastewater must be treated to remove nitrite and other contaminants before the water can be safely disposed of. When boiler maintenance water is mixed with other wastes in the ship's bilge, the disposal charge by contractors can be as high as $3.50 per gallon. If the sodium nitrite stream is segregated from the other wastes at the point of generation, the disposal cost is slightly less but still can be as high as $2.50 per gallon.

In response to the Chief of Naval Operations' goal of a 50 percent reduction in hazardous waste generated Navy-wide, Naval Facilities Engineering Service Center (NFESC) has been tasked by the Naval Facilities Engineering Command to investigate sodium nitrite wastewater treatment technologies. NFESC has developed a proven denitrification process using sulfamic acid that can chemically convert sodium nitrite to nitrogen gas without the formation of nitrate and precipitate heavy metals before discharging the treated water to the sewer system. The NFESC-developed denitrification process has the potential of reducing the maximum disposal cost by at least 95% from $3.50 per gallon disposal cost to $0.14 per gallon process operating cost.

The chemical wastewater treatment process uses stoichiometric amount of sulfamic acid to reduce nitrite to nitrogen gas. The overall equation for this chemical reaction is shown as follows (equation 1):

$$\underset{\text{Sulfamic Acid}}{NH_2SO_3H} + \underset{\text{Sodium Nitrite}}{NaNO_2} \Leftrightarrow \underset{\text{Monosodium Sulfate}}{NaHSO_4} + \underset{\text{Water}}{H_2O} + \underset{\text{Nitrogen Gas}}{N_2(g)} \qquad (1)$$

From Equation 1 it can be seen that this is an acidic reaction and, with waterjet cleaning water, the wastewater pH is expected to decrease from its normal range of 7 or 8. The final pH depends on the initial nitrite concentration of the wastewater. Typically, the pH after the nitrite reduction process for the boiler maintenance wastewaters ranges from 2 to 3.

The boiler maintenance wastewaters also contain various dissolved heavy metals that are toxic. These heavy metals can be removed from the wastewater with the addition of sodium hydroxide solution which raises the wastewater pH to a value of about 11 causing the metals to precipitate from solution, typically forming small fluffy or gelatinous particles called "floc". Flocculating can be enhanced by adding a liquid polymer to the solution. By decreasing the mixing intensity, small floc particles (agglomerate) will stick together forming larger particles that can be removed by filtration. Following filtration wherein the heavy metals are removed with the flocs, the wastewater pH will be lowered with a sulfuric acid solution to about 7 before discharging to the sewage system.

It is necessary to restrict the amount of air-liquid contact during the denitrification process because oxygen from the air will tend to react with the nitrite producing nitrate. Nitrate, which is also a pollutant, is not susceptible to the sulfamic acid reduction and will remain in the wastewater after the treatment is complete. To minimize the formation of nitrate, long term storage or excessive mixing of the wastewater must be avoided.

A permit to operate the NWTS at SIMA San Diego was obtained from the California Environmental Protection Agency (Cal-EPA) Department of Toxic Substances Control (DTSC). Permit for discharging the treated water to the industrial sewer was obtained from the San Diego County Sanitation District.

Economic analyses were performed using data obtained from NWTS field demonstration tests. The results showed that treatment cost using the mobile NWTS is approximately $0.14 per gallon.

The objective of the User Data Package (UDP) document is to provide field users with necessary information to implement the developed technology in treating sodium nitrite wastewater on site in conjunction with the existing successfully implemented NFESC Waterjet Wastewater Recycling Unit.

SECTION 2

BACKGROUND

2.1 WASTEWATER SOURCES

The wastewater streams that are to be treated by the NWTS are typically generated during boiler maintenance activities. Regular boiler maintenance of Navy surface ships consist of four activities that generate sodium nitrite wastewater. These are (1) waterjet tube cleaning; (2) boiler lay-up; (3) boiler hydrostatic pressure testing, and (4) rinsing. The Navy uses sodium nitrite to prevent corrosion of the boiler during maintenance operations.

The waterjet tube cleaning operation uses high water pressure (up to 10,000 psi) to remove the soft deposit on the inside of the boiler's steam generating tubes. Each tube is cleaned by passing a cleaning lance down the tube. The cleaning lance consists of 20 to 25 foot lengths of flexible braided stainless steel tube, approximately 1/4 inch in diameter, with a nozzle attached at the free end. In order to prevent flash rusting of the tube surfaces, sodium nitrite is added to the high pressure cleaning water, which flows at rates up to 20 gallons per minute. The wastewater generated from the waterjet cleaning process, containing sodium nitrite, heavy metals, and suspended solids, is delivered to a trailer mounted recycle unit which is designed for collecting, settling, filtering, and reconditioning the wastewater for reuse. Upon completion of the boiler cleaning process, the wastewater stored in the recycle unit will be pumped to the NWTS for nitrite and heavy metals removal, then discharged to the sewer.

The boiler lay-up operation is conducted after the required maintenance operations are complete and before the ship readies the boiler for use. The lay-up process consists of filling the boiler with nitrite process water during the boiler shutdown periods to inhibit corrosion. Before placing the boiler into operation, the lay-up water and required rinse water will be discharged to the NWTS for treatment.

The boiler hydrostatic testing operation consists of filling the boiler with nitrite process water and applying high pressure for leak testing. Upon completion of the leak test, the hydrostatic testing water will be pumped to the NWTS for treatment.

Following the boiler maintenance activities as described above, the equipment involved in the boiler maintenance need to be cleaned and rinsed. The rinsing water contains nitrite which is required to be lowered to an acceptable level.

2.2 WASTEWATER CHARACTERISTICS

The typical characterization of the nitrite wastewater generated at San Diego activities and local discharge limits used for design of the NWTS are presented in Table 2-1.

Table 2-1

NWTS Wastewater Characteristics and Discharge Limits

Contaminant	Expected Inf. Concentration (mg/L)	Daily-Max Effluent Limitations (mg/L)
Nitrite - N	20 - 400	1.00
Cadmium	0.02	0.69
Chromium	0.20	2.77
Copper	2 - 20	3.36
Iron	15.0	--
Lead	0.5	0.69
Nickel	0.5	3.96
Zinc	0.5	2.61
Oil and Grease	NA	500
pH	7 - 8	6.0 - 9.0
TSS	50	30

The heavy metal concentrations in the received wastewater are usually below the discharge limits. Therefore, the wastewater is designed as regular wastewater stream.

2.3 WASTEWATER QUANTITY

Per previous pilot plant study report (ref 3), the estimated volume of nitrite wastewater generated at a typical Naval Shipyard is approximately 400,000 gallons per year. For example, at the San Diego Naval Station (NAVSTA), waterjet operations are normally conducted once per month. Each operation typically produces a quantity of up to 2,000 gallons. Lay-up operations are currently conducted approximately 4 times for every waterjet operation. Wastewater production for each lay-up operation would be approximately 2,000 gallons to 7,000 gallons. The total wastewater production rate is estimated to range from 100,000 gallons to 400,000 gallons per year at San Diego NAVSTA. This quantity of water generated is the typical yearly rate for most Naval Stations, Naval Shipyards and Ship Repair Facilities.

SECTION 3

NITRITE WASTEWATER TREATMENT SYSTEM DESCRIPTION

3.1 INTRODUCTION

3.1.1 Intended Use

This mobile NWTS was designed to treat nitrite and to remove heavy metals from Navy boiler maintenance nitrite wastewaters, especially generated from Waterjet Wastewater Recycling Unit at piers as shown by Figure 3-1. Treated wastewaters can be discharged to an industrial sewer. Spent filter cartridges and deposited heavy metals must be disposed of as hazardous waste.

3.1.2 Treatment Capacity

This unit will treat sodium nitrite contaminated wastewater in a batch mode. Each batch will have an approximate capacity of 500 gallons. The design treatment cycle time of each batch is approximately 4 to 6 hours. Depending on actual wastewater characteristics, the cycle time may be significantly shorter or longer.

3.1.3 Limitations

The system can't be operated when the ambient temperature is below 32 degrees Fahrenheit. The system is designed to be operated with a maximum wind load of 30 mph. The system can't process sludges or wastewater containing high concentrations of solids, oils, or trash. The system should not be transported with the main tank (T-101) full of water.

3.2 GENERAL DESCRIPTION OF THE UNIT, UNIT COMPONENTS AND ACCESSORIES

Major components of the NWTS (Figures 3-2 and 3-3) include a recirculating pump, a 600 gallon reaction tank with an adjustable speed mixer, four (4) chemical storage containers, chemical cabinet, four (4) metering pumps, and various process control elements. These components are mounted on an open trailer. The trailer mounted unit has a total operating weight of 7,123 pounds. The trailer is not designed for street use. The trailer has a design road speed rating of 30 mph.

Figure 3-1 NWTS and Waterjet Recycling Unit on Pier

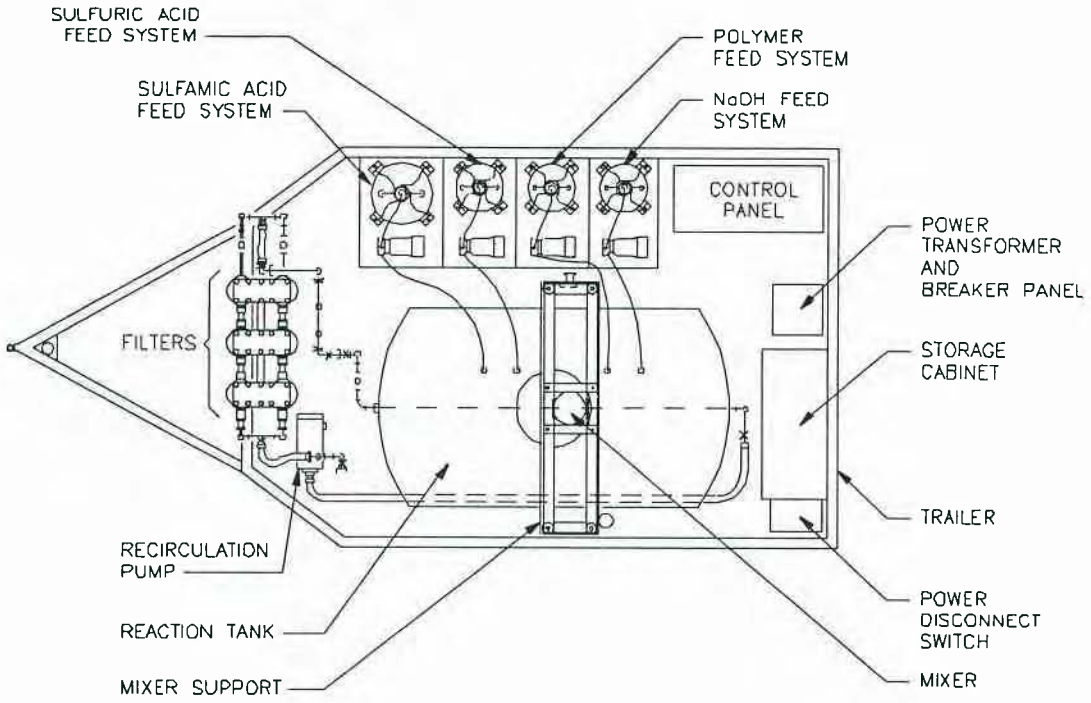


Figure 3-2 NWTS Layout

Figure 3-3 NWTS Side View - Control Panel, Chemical Cabinet, ORP and pH Transmitter, Filters Reaction Tank and Trailer

The wastewater will be pumped into the **REACTION TANK** from either the waterjet wastewater recycling system storage tanks or from a separate storage tank. The reaction tank has a capacity of 600 gallons with marks at one end to show the working volume in 50 gallon increments.

An **ADJUSTABLE SPEED MIXER** is mounted above the reaction tank to mix the tank contents. The mixer system consists of a mixer, a DC motor, and a speed controller. The speed controller is mounted on the control panel. There is a speed adjustment knob on the controller for manual mixing speed control. The mixer has a maximum speed of 350 rpm. During the nitrite reducing process and the pH adjustment process, using a mixing speed close to approximately 250 rpm is recommended. Low mixing speed should be maintained to enhance floc agglomeration during the heavy metals removal stage. In this stage, a mixing speed of 100 rpm is recommended.

A **SULFAMIC ACID STORAGE CONTAINER** is provided to store 10 percent sulfamic acid solution for nitrite reduction. The sulfamic acid storage container is made of polypropylene with a capacity of 13 gallons. The container is equipped with handles and cap for loading and unloading. This container is stowed on the trailer in the chemical cabinet.

A **SULFAMIC ACID METERING PUMP** is provided to pump sulfamic acid (NH_2SO_3H) solution into the reaction tank to reduce nitrite. The pump is a positive displacement type with built-in manual adjustment knobs for setting the stroke length and stroke frequency. A **SULFAMIC ACID PUMP STROKE FREQUENCY CONTROLLER** is furnished on the control panel for automatic control of the pump. The sulfamic acid metering pump is linked to an Oxidation & Reduction Potential (ORP) controller with a hand-off-auto switch. See the description of the ORP feedback control system (below) for details about this system.

An **ORP** feedback control system is provided to sense the nitrite concentration in the wastewater. The ORP control system consists of an **ANALYZING ELEMENT (SENSOR), TRANSMITTER, and INDICATING CONTROLLER.** The analyzing element and transmitter are mounted on the recirculating pipeline and the indicating controller is mounted on the control panel. The analyzing element is a disposable type.

A **PROGRAMMABLE LOGIC CONTROLLER (PLC)** is provided to control the entire process. Control of the nitrite reduction process will be accomplished by monitoring ORP and pH using the PLC as the "control brain". The PLC receives control signals from the PLC analyzer. When the ORP reaches the control set point, the PLC will send a control signal to the sulfamic acid metering pump for shutoff. The PLC also receives a control signal from the pH analyzer. When the slope of the reactor solution pH decreases to a pre-set value (no matter what the ORP value is), the PLC will send a control signal to the sulfamic acid pump for shutoff. Figure 3-4 shows the detailed PLC program flow chart.

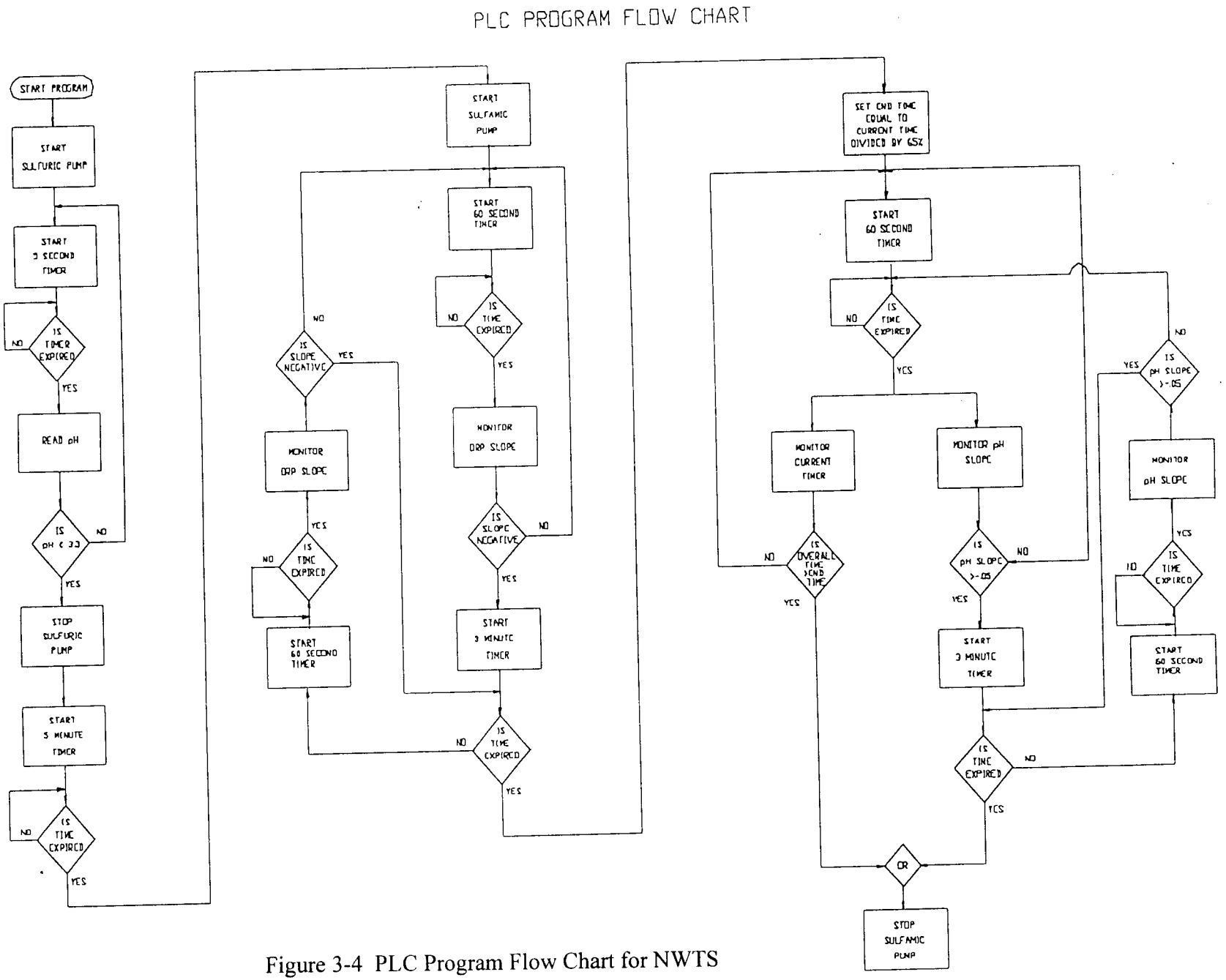


Figure 3-4 PLC Program Flow Chart for NWTS

A **SODIUM HYDROXIDE STORAGE CONTAINER** is provided to store 20 percent sodium hydroxide solution for raising the wastewater pH after the nitrite reduction process is complete. The container is made of polypropylene with a capacity of 5.5 gallons. The container is equipped with handles and cap for loading and unloading. This container will be stored on the trailer in the chemical cabinet.

A **SODIUM HYDROXIDE METERING PUMP** is provided to pump sodium hydroxide (NaOH) solution into the reaction tank to raise the pH and initiate the formation of heavy metals floc. The pump is a positive displacement type with built-in manual adjustment knobs for setting the stroke length and stroke frequency. A **SODIUM HYDROXIDE PUMP STROKE FREQUENCY CONTROLLER** is mounted on the control panel for automatic control of the pump. The sodium hydroxide metering pump is activated by the pH controller. By setting the pH controller to the high pH mode, the sodium hydroxide metering pump is automatically shutoffs when the solution pH in the reaction tank reaches the pre-set value.

A **pH SENSOR with TRANSMITTER** is mounted on the reaction tank to monitor wastewater pH in the reaction tank. A **pH INDICATING CONTROLLER** is mounted on the control panel to receive signals from the pH transmitter and to send the signal to the PLC to control the sulfamic acid metering pump, the sodium hydroxide metering pump and the sulfuric acid metering pump. The pH sensor is a disposable type.

A **SULFURIC ACID STORAGE CONTAINER** is provided to store 10 percent sulfuric acid solution for pH adjustment downward. The container is made of polypropylene with a capacity of 5.5 gallons. The container is equipped with handles and cap for loading and unloading. This container will be stored on the trailer in the chemical cabinet.

A **SULFURIC ACID METERING PUMP** is provided to pump sulfuric acid solution into the reaction tank to adjust the pH downward to meet discharge permit requirements for pH. The pump is a positive displacement type with built-in manual adjustment knobs for setting of stroke length and stroke frequency. A **SULFURIC ACID PUMP STROKE FREQUENCY CONTROLLER** is mounted on the control panel for remote control of the pump. The sulfuric acid metering pump will be activated by the pH controller. By setting the pH controller to the low pH mode, the sulfuric acid metering pump will be automatically shutoff when solution pH in the reaction tank reaches the pre-set value.

A **POLYMER STORAGE CONTAINER** is provided to store anionic polymer for enhancing heavy metal particle agglomeration. The container is made of polypropylene with a capacity of 5.5 gallons. The container is equipped with handles and cap for loading and unloading. This container will be stored on the trailer in the chemical cabinet.

A **POLYMER METERING PUMP** is provided to pump anionic polymer into the reaction tank. The pump is a positive displacement type with built-in manual

adjustment knobs for setting the stroke length and stroke frequency. A start-stop switch is provided to operate the pump.

A **RECIRCULATING PUMP** is provided to circulate the reaction tank solution and heavy metals floc through the filter cartridges. Wastewater can also be transferred into or out of the reaction tanks using the recirculating pump. The pump is a centrifugal type with a design flow capacity of 40 gpm at 32 psi.

Six **CARTRIDGE FILTERS** are provided to remove floc formed in the heavy metals precipitation stage. The filtration system consists of two parallel filter trains. One filter train is used at a time. Each train has three (3) filters that operate in series. The filters in each train are arranged with progressively finer mesh/pore sizes of 50, 25 and 5 microns to maximize the filter run time and solids capture.

A 200 watt incandescent **UTILITY LIGHT** is mounted on the adjustable speed mixer support. The utility light is provided to illuminate the work area during night operations. An on-off switch on the control panel is provided to operate the light.

The **CONTROL PANEL** (Figure 5-1) contains the pump switches, pump operating lights, metering pump controllers, pH meter controller, ORP controller, PLC, and mixer operating light, switch, and controller. Electrical service for the system must be 480 volt, 3 phase, 60 hertz power. The panel contains a secondary transformer for 110 volt, single phase control circuits.

The **TRAILER** is a four wheel type designed for low speed (up to 30 mph) conveyance of the unit. The trailer should not be used for highway conveyance. An adjustable height towing lunette is provided to connect the trailer with a tow vehicle. Four trailer jacks are provided to level the trailer while it is parked. Blocks should be placed under the trailer wheels to prevent rolling while the trailer is parked.

3.3 PROCESS DESCRIPTION

The Nitrite Wastewater Treatment System (NWTS) process uses stoichiometric amounts of sulfamic acid to reduce nitrite to nitrogen gas. In addition to nitrite, wastewaters generated in boiler maintenance activities typically contain heavy metals (notably copper) in concentrations exceeding the National Pollution Discharge Elimination System (NPDES) Standards. Metal precipitation using alkaline pH conditions is incorporated into the treatment system for metals removal following the nitrite reduction step.

The reaction kinetics of the denitrification process dictate that the reactor configuration should be either batch or plug flow. A batch process was selected for its simplicity and suitability for implementation on a trailer. The system is trailer mounted so it can be used in conjunction with the existing NFESC Waterjet Wastewater Recycling Unit, which recycles 90 percent of the wastewater from waterjet operations. Due to space limitations on the proposed trailer and because wastewater production rates are low, the three key treatment processes - sulfamic acid addition, metal precipitation, and

neutralization - are conducted sequentially in a single batch reactor. Heavy metals precipitate (sludges) are removed by conventional filtration. Figure 3-5 shows the process flow diagram for the nitrite treatment system which consists primarily of nitrite reduction, metal precipitation, neutralization, and filtration.

The wastewater is pumped into the reaction tank from either the Waterjet Wastewater Recycling Unit storage tanks or from a separate storage tank. The reaction tank is equipped with an adjustable speed agitator to completely mix the tank contents while minimizing air intrusion into solution. It is necessary to restrict the amount of air-liquid contact prior to and during the denitrification process because oxygen from the air will tend to oxidize nitrite to nitrate which is a more stable compound and not susceptible to the sulfamic acid reduction. Because nitrate is also a regulated chemical by the Clean Water Act, it is necessary to minimize its formation to the maximum extent possible.

3.3.1 Sulfamic Acid Addition

A 10% sulfamic acid ($NH_2 SO_3 H$) solution is metered into the reactor to reduce the nitrites. The sulfamic acid is added in stoichiometric proportion to the nitrite in the wastewater. Where wastewater nitrite concentrations are known, the necessary sulfamic acid dosage can be calculated directly. However, in most cases, the nitrite concentration is unknown, and an oxidation-reduction potential (ORP) feedback control loop is used. The ORP control system consists of an analyzing element (probe), transmitter, and indicating controller. The ORP is a function of solution pH, type of ions and their concentrations in the wastewater, electromotive force (EMF) between ionic species, and wastewater temperature. Typical ORP for boiler maintenance wastewater is approximately 180 to 220 mV. Because the reaction of nitrite reduction will force the wastewater towards a higher ORP value, a maximum ORP will occur during the reaction. After the maximum ORP occurs, a large portion of the nitrite in the reactor solution will be removed and the ORP will decrease. Test have shown that this occurs at about 65% of the completion of the reaction. In addition, the pH of the solution will tend to decrease as nitrite is removed from the solution. The slope of the pH curve will flatten out during the reaction. A programmable logic controller (PLC) is installed on the NWTS to detect the occurrence of the ORP changes to determine when to stop the process as shown in Figure 3-4.

When nitrite concentration in the reactor solution is reduced to a low level, a combination of weak chemical reaction and lag of reactor mixing may cause signals transmitted from the analyzing element to become unstable. To avoid missing the ORP control point which causes endless dosing of the sulfamic acid, the PLC also sends a control signal to the sulfamic acid metering pump for shutoff when the wastewater pH slope decreases to a pre-set value. Data collected from the NWTS demonstration tests show that slope of the pH curve will tend towards a pre-set value as the nitrite reaction is complete. An additional backup is provided by shutting the unit down when the pH reaches a low value of 2. Changing of the PLC program or set points such as the shutoff

PROCESS FLOW DIAGRAM FOR THE NITRITE WASTEWATER TREATMENT SYSTEM

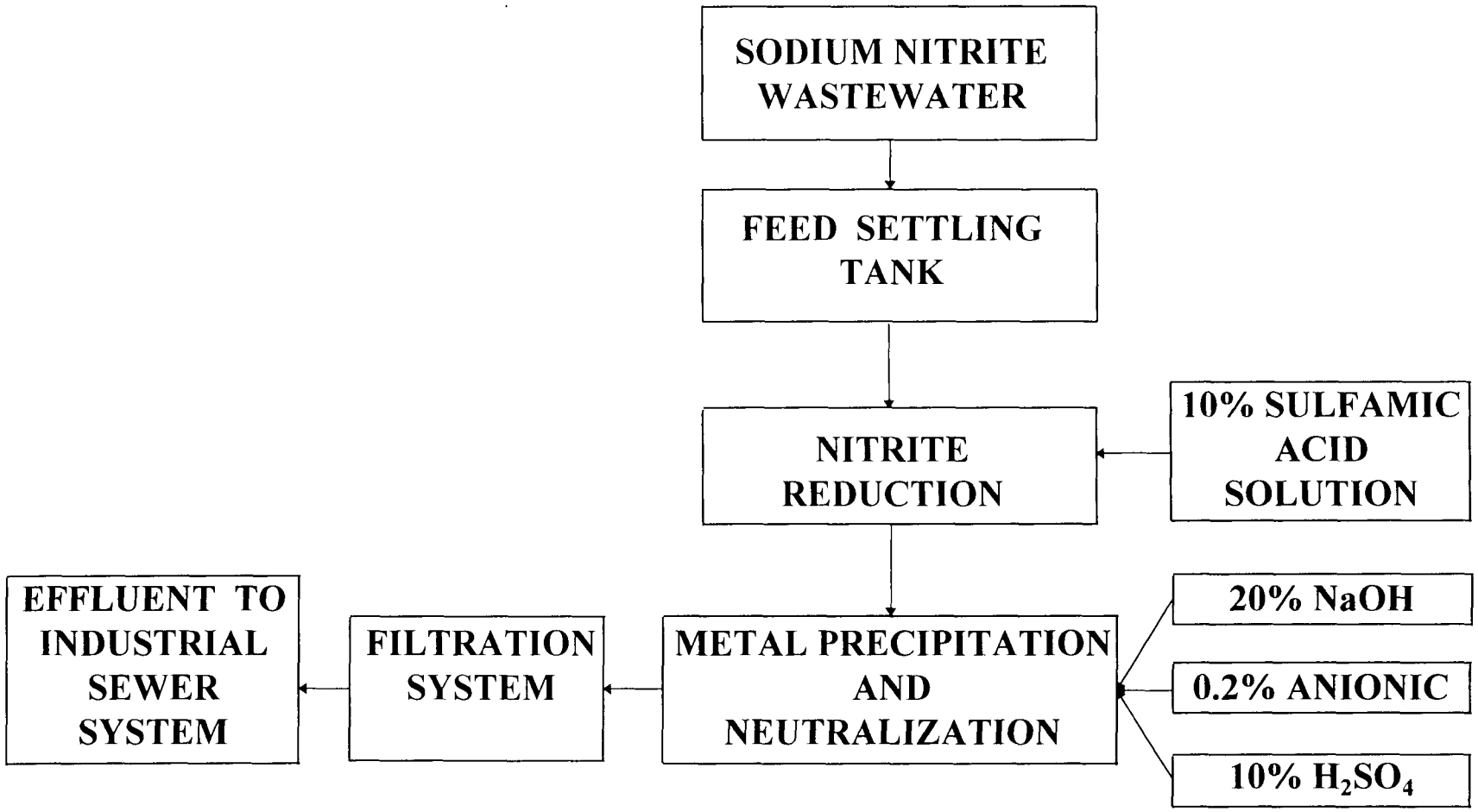


Figure 3-5 Process Flow Diagram for the NWTS

pH slope and the "ORP versus time slope change" duration can be accomplished by using an external IBM compatible computer. Note that the computer and interface cable used for connecting the PLC and computer are not provided with the NWTS.

Figures 3-6 and 3-7 show two different test runs conducted at SIMA San Diego.

3.3.2 Metal Precipitation

Following denitrification, metals precipitation is achieved by the addition of 20% sodium hydroxide solution which raises the pH to about 11. The pH adjustment is controlled automatically using a pH control system including an analyzing element, transmitter, and PLC. Flocculation of the heavy metals precipitate is enhanced using an anionic polymer as required. The polymer is added to the reactor automatically or manually using the metering pump. The mixer speed is manually adjusted to enhance particle agglomeration. Following flocculation, the wastewater is pumped to filters for removal of the solids. The filtration system consists of two parallel filter trains. Each train has three (3) filters operated in series. Each train of filters is arranged with progressively finer mesh/pore sizes to maximize filter run time and precipitate capture. Recommended mesh/pore sizes for each filter train are 50 μ, 25 μ, and 5 μ in series. Filtered wastewater is recirculated back to the reactor tank prior to pH neutralization.

3.3.3 Neutralization

Following filtration, the wastewater pH is adjusted from 11 to approximately between 8 and 6 using sulfuric acid to comply with discharge permit requirements. Sulfuric acid (10 percent solution) is automatically added to adjust the wastewater pH using an analyzing element (pH probe), transmitter, and PLC.

The treated wastewater should then be sampled for chemical analysis and then pumped to the activity industrial sewer system or outfall depending on location. Spent filter cartridges should be containerized and properly disposed of as hazardous waste.

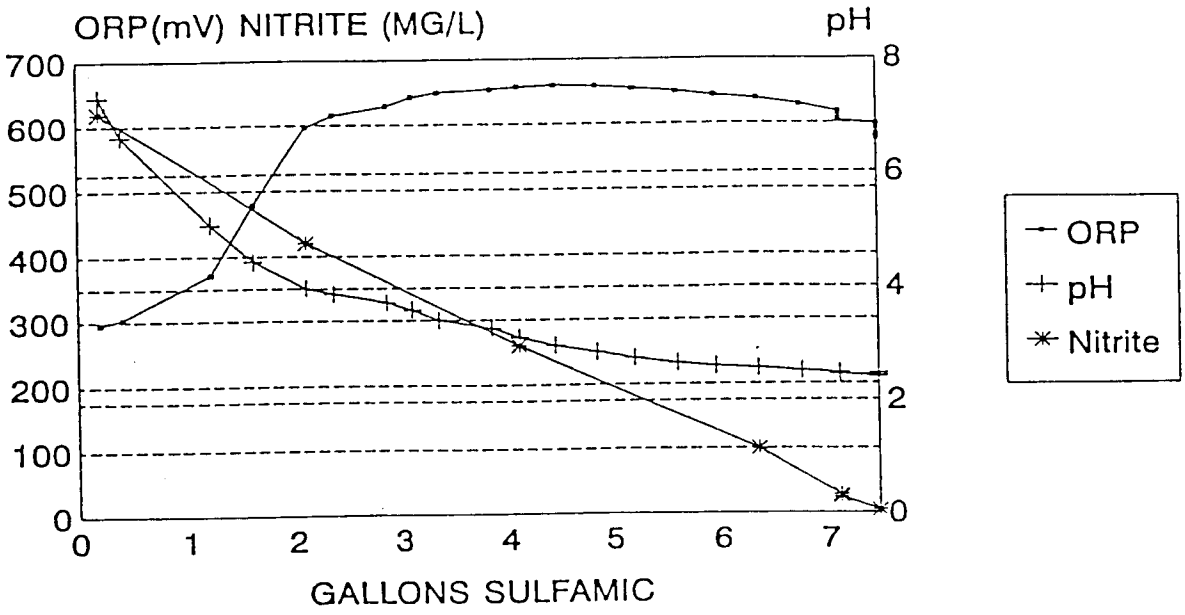


Figure 3-6 Test Run as a Function of Sulfamic Acid Addition in Gallon

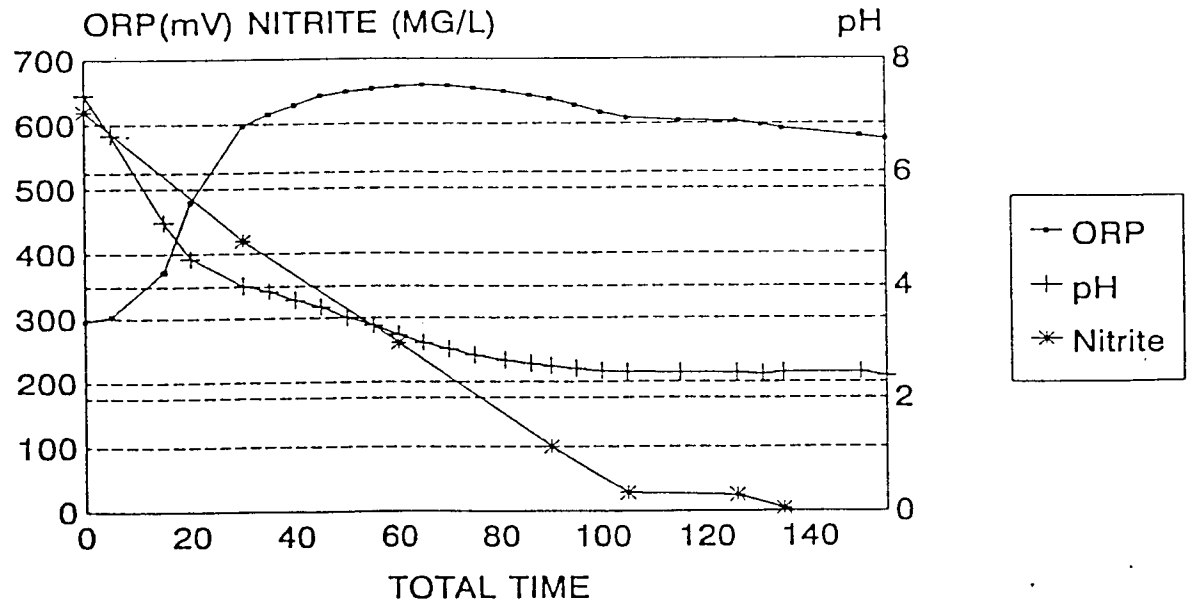


Figure 3-7 Test Run as a Function of Process Time in Minutes

3.4 PROCESS CRITERIA

3.4.1 Process Cycle Time

Process	Basis
General	
Capacity	500 Gallons
Operation	Batch
Cycle Time	
Fill	15 minutes
Sulfamic Addition	60-120 minutes
Metal Precipitation	10 minutes
Filtration	60 minutes
Neutralization	10 minutes
Discharge	10 minutes
Total	165-225 minutes

3.4.2 Nitrite Reduction

Sulfamic Acid Dosage	1.45 lb / lb $NaNO_2$
Sulfamic Acid Concentration	10%
Sulfamic Acid Volume	6 to 13 gallon/batch
Interim pH	2.0-3.0

3.4.3 Metal Precipitation

Operating pH	10.0-11.0
NaOH Dosage	3 to 6 pounds/batch
NaOH Solution Concentration	20%
NaOH Solution Volume	2 to 3 gallons/batch
Polymer Type	Anionic (Polyacrylamide)
Polymer Dosage	0.5-5 mg/L
Polymer Concentration	0.2%
Polymer Volume	1.25 to 2.0 gallons/batch

Max. Filter Operating Pressure	100 psi
Sludge Cake Mass (wet at 30%)	1.0 to 2.5 pounds/batch

3.4.4 Neutralization

Sulfuric Acid Dosage	0.2 to 1.0 pounds/batch
Sulfuric Acid Concentration	10%
Sulfuric Acid Volume	1.5 to 2.5 gallons/batch
Final pH	6.0-8.0

3.4.5 Summary Table of Volumes

	Reduction	Metals Precipitation	Neutralization	Filter
Process Flow	500 gallons	500 gallons	500 gallons	--
Sulfamic Acid at 10%	6 to 13 gallons	--	--	--
Sodium Hydroxide at 20%	--	2.0 to 3.0 gallons	--	--
Polymer at 0.2%	--	1.25 to 2.0 gallons	--	--
Sulfuric Acid at 10%	--	--	1.5 to 2.5 gallons	--
No. of Filter Cartridges				3 to 6
Solids at 30% dwt.	--	--	-	0.05 ft^3

3.5 MAJOR EQUIPMENT LIST

The following is a list of major equipment designed for the NWTS. Part numbers refer to Figures 3-8 through 3-13.

3.5.1 Tanks

T-101	Reaction Tank	700 gallons
T-102	Sulfamic Acid Day Tank	13 gallons
T-103	Sodium Hydroxide Day Tank	5.5 gallons
T-104	Sulfuric Acid Solution Day Tank	5.5 gallons
T-105	Polymer Day Tank	5.5 gallons

3.5.2 Pumps

Pump No.	Pump Type	Pumping Rate	Pumping Head	Motor
P-100	Transfer Pump, Filling	25 to 135 gpm	30 to 135 ft	2 HP, single phase, 230 volts
P-102	Sulfamic Acid Metering Pump	0.38 to 76 lph	Max. 25 psig	150 Watts, single phase, 120 volts
P-103	Sodium Hydroxide Metering Pump	0.38 to 76 lph	Max. 25 psig	150 Watts, single phase, 120 volts
P-104	Sulfuric Acid Metering Pump	0.38 to 76 lph	Max. 25 psig	150 Watts, single phase, 120 volts
P-105	Polymer Metering Pump	0.38 to 76 lph	Max. 25 psig	150 Watts, single phase, 120 volts

3.5.3 Mixers

M-101 1/3 HP DC Motor & Speed Control Regulator (SCR)

3.5.4 Filters

F-1,2,3,4,5,6 Cartridge Filters, 10 inches in length.

3.5.5 Trailer

The trailer contains an 8 foot by 10 foot flat area, with a tow hitch at the front, and four support feet around the periphery of the trailer. A storage cabinet is mounted on the back of the trailer for spare parts storage.

3.5.6 Key Instruments

- pH Sensor, TEFZEL body with VITON O-rings, automatic temperature compensation, maximum operating temperature 85°C.
- pH Controller, measurement range 0-14, accuracy ±0.01 pH, snap-acting output signal, dot-matrix liquid crystal display.
- ORP Sensor, TEFZEL body with VITON O-rings, automatic temperature compensation, maximum operating temperature 85°C.
- ORP Controller, measurement range -1400 to +1400 mV, accuracy ±1 mV, snap-acting output signal, dot-matrix liquid crystal display.
- Programmable Logic Controller (PLC), four point 120 vac power input, four point analog input, four point relay output, and one microprocessor.
- Pressure Indicators, pressure range 0-50 psi with diaphragm seal, accuracy 1% (total of 2).
- Mixer Motor Speed Controller, wall mounted solid state unit to convert AC to DC, adjust motor speed from 350 rpm to 70 rpm.
- Rotameter, 0-40 gpm reading capacity, acrylic metering tube, 316 stainless steel float, PVC end.

3.6 WEIGHTS

Equipment		Weight (pounds)	
Tanks:			
	T-101	4271 pounds	Full
	T-102	88 pounds	Full
	T-103	55 pounds	Full
	T-104	50 pounds	Full
	T-105	45 pounds	Full
Pumps:			
	P-101	58 pounds	
	P-102	19 pounds	

	P-103	19 pounds
	P-104	19 pounds
	P-105	19 pounds
Mixer:		
	M-101	100 pounds
Filters		90 pounds
Control Panel		150 pounds
Power Panel		60 pounds
Storage Cabinet		80 pounds
Trailer		2,000 pounds
TOTAL		7,123 pounds

3.7 FACILITY REQUIREMENTS

3.7.1 Electrical Supply

The NWTS requires one (1) 30 amp, 3 pole, 440 volt service connection (receptacle) for power.

3.7.2 Waste Disposal

3.7.2.1 Liquid Waste Disposal

Treated nitrite wastewater should be discharged to the industrial wastewater sewer.

3.7.2.2 Solid Waste Disposal - Hazardous (Metals)

Spent filter cartridges should be containerized in labeled, DOT-approved drums and disposed of as a hazardous waste.

3.8 STRUCTURAL DESIGN

Structural design for the NWTS was performed based on the following guidelines:

- Suitable for highway transportation (DOT)
- Transportable
- Meet ASME, ASTM and NEMA standards

3.9 MECHANICAL DESIGN

Mechanical design for the NWTS was performed based on the Uniform Plumbing Code 1993.

3.10 INSTRUMENTATION

Instrumentation design for the NWTS was based on the ISA Standard.

3.11 ELECTRICAL

Electrical design for the NWTS was performed based on the following guidelines:

- National Electrical Code (NEC), 1993 Edition
- Weather proof panels (NEMA 4 enclosures)
- Power supply is 440 VAC, 3 phase.
- Provide lighting for night operation

3.12 AMPERAGE REQUIREMENTS

Equipment	Amps	HP
P-101	12	2
P-102	1.5	150 watts
P-103	1.5	150 watts
P-104	1.5	150 watts
P-105	1.5	150 watts
M-101	3	1/3

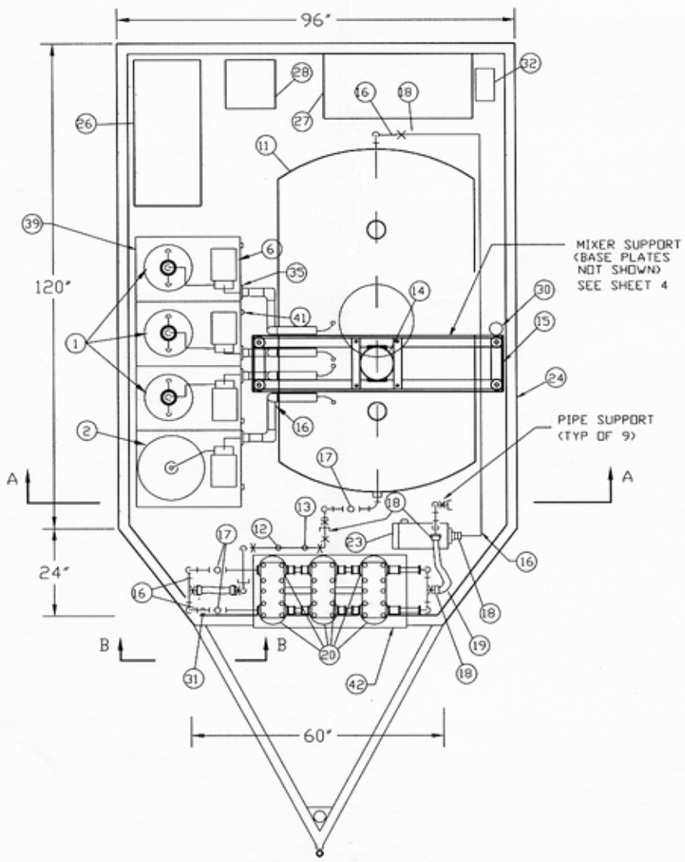
3.13 DESIGN DRAWINGS

Design drawings for the NWTS are attached at the end of this Section as Figures 3-8 through 3-13.

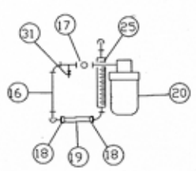
DWG. NO.	SH	REV

REVISIONS

ZONE	REV	DESCRIPTION	DATE	APPROVED



GENERAL LAYOUT
TOP VIEW



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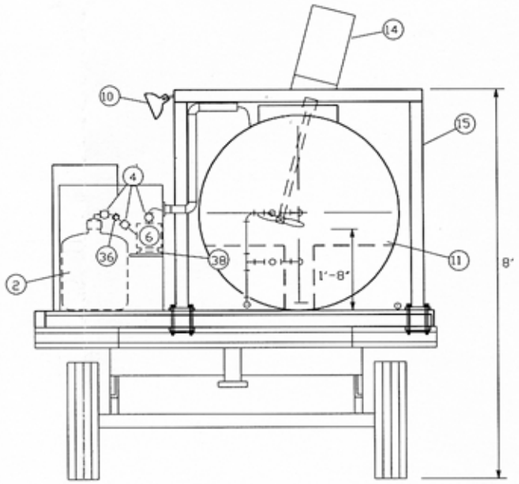
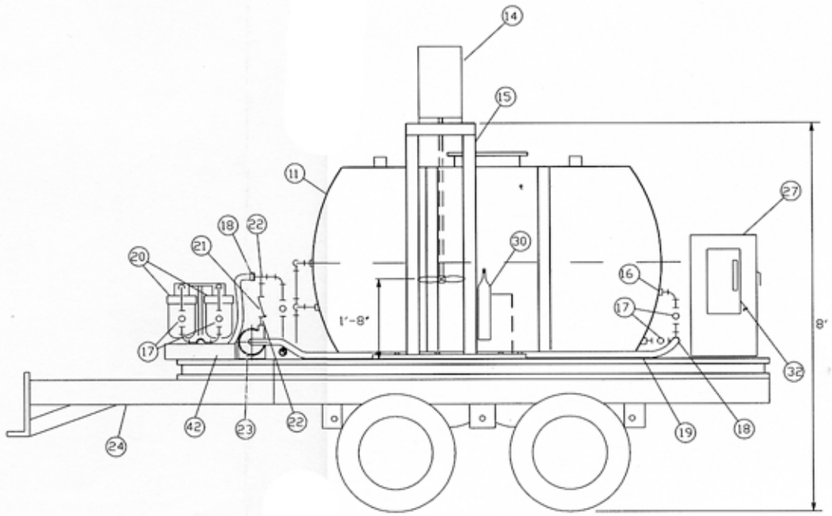


SECTION A-A



GENERAL LAYOUT
SIDE VIEW

NO	DRAWING TITLE	DWG NO
	REFERENCE DRAWING(S)	

UNLESS OTHERWISE NOTED DIMENSIONS ARE IN INCHES. TOLERANCES ARE IN ACCORDANCE WITH COMMERCIAL PRACTICE UNLESS OTHERWISE INDICATED ON DRAWING

	SIGNATURE	DATE
PREPARED	J. MCGILLIAN	
CHECKED		
PROJ ENGR		

NAVY APPROVAL

SECT. HD		
BR. HD		
DEPT. DIR		
APPROVED		DATE

FOR THE CMDG. OFFICER - CDNSWC

DEPARTMENT OF THE NAVY PHILADELPHIA, P.A. 19112-5083
CARDEROCK DIVISION
NAVAL SURFACE WARFARE CENTER

MOBILE NITRITE WASTWATER TREATMENT SYSTEM
DESIGN DRAWINGS

SIZE	FSCM NO.	ESWBS	DWG NO.	REV
B				

SCALE | SHEET 1 OF 6

Figure 3-8 NWTS Layout - Sheet 1

DWG. NO.	SH	REV

REVISIONS

ZONE	REV	DESCRIPTION	DATE	APPROVED

SPECIFICATIONS AND NOTES:

1. CHEMICAL CONTAINER. POLYPROPYLENE CARBOY WITH HANDLES. THE CONTAINER SHALL HAVE MINIMUM CAPACITY OF 55 GALLONS. THE CONTAINER SHALL BE SUITABLE FOR OUTDOOR USE. DIMENSIONS: O.D. 11 5/16", HEIGHT 18 1/2", MOUTH 2 1/2".

2. CHEMICAL CONTAINER. POLYPROPYLENE CARBOY WITH HANDLES. THE CONTAINER SHALL HAVE MINIMUM CAPACITY OF 13 GALLONS. THE CONTAINER SHALL BE SUITABLE FOR OUTDOOR USE. DIMENSIONS: O.D. 14 13/16", HEIGHT 26 1/2", MOUTH 2 1/2".

3. STEEL HOLD DOWN LUGS. STEEL HOLD DOWN LUGS WITH MINIMUM DIMENSIONS OF 2" X 6". CONTRACTOR SHALL ANCHOR THE LUGS WITH 1/4" - 316 SS STEEL ANCHOR BOLTS. PROVIDE STEEL PLATE UNDERNEATH GRATING FLOOR OF THE TRAILER FOR TIGHTENING OF THE ANCHOR BOLTS. FURNISH LIQUID-TIGHT EPDM SEALS WITH ALL BOLT/CONTAINER PENETRATIONS. TYPICAL OF 7.

4. BALL VALVE. 1/2" PVC BALL VALVE WITH TEFLON SEALS. CONTRACTOR SHALL INSTALL AN 1/2" PVC TUBE INSERT FITTING TO THE VALVE FOR THE CONNECTION OF VALVE AND PLASTIC TUBING TO THE PUMP AS SHOWN ON THE DRAWING. PROVIDE A STAINLESS WORM DRIVE HOSE CLAMP TO TIE THE 1/2" TUBING ON THE INSERT FITTING.

5. CLEAR BRAIDED PVC TUBING. 1/2" I.D.

6. CHEMICAL METERING PUMP. PUMP SHALL BE ACTIVATED BY THE SIGNAL RECEIVED FROM PH ANALYZER. THE PUMP SHALL BE POSITIVE DISPLACEMENT TYPE WITH FLOW CAPACITY OF 0.38 TO 76 LPH AT MAXIMUM PRESSURE OF 25 PSIG. THE STROKE LENGTH AND STROKE FREQUENCY SHALL BE MANUALLY ADJUSTABLE. THE CONTRACTOR SHALL ALSO INSTALL A PUMP CONTROLLER ON THE MAIN CONTROL PANEL TO MANUALLY ADJUST PUMP STROKE FREQUENCY. THE CONTROLLER SHALL BE DIGITAL DISPLAY TYPE. OPERATION LIGHT SHALL BE PROVIDED TO INDICATE PUMP OPERATING. A FOOT VALVE WITH INTEGRAL ONE PIECE STRAINER SHALL BE PROVIDED FOR THE SUCTION LINE; AND AN INJECTION CHECK/BACK PRESSURE VALVE WITH 1/2" NPT MALE CONNECTION FOR THE INJECTION POINT. THE PUMP DRIVE SHALL BE TOTALLY ENCLOSED WITH NO EXPOSED MOVING PARTS. PUMP DRIVE SHALL BE SUITABLE FOR OPERATION ON 115 VOLTS AND SINGLE PHASE POWER. ELECTRICAL POWER SHALL NOT EXCEED 56 WATTS UNDER FULL SPEED AND MAXIMUM PRESSURE CONDITIONS. THE CHEMICAL METERING PUMP SHALL BE MADE BY LIQUID METRONICS INC. AS MODEL C741-34 WITH MP1000RC CONTROLLER OR EQUAL. CONTRACTOR SHALL PROVIDE 1/2" PVC TUBE INSERT FITTINGS TO SUCTION AND DISCHARGE SIDES OF THE PUMP FOR THE CONNECTION OF PUMP AND PLASTIC TUBINGS. THE INSERT FITTING ON SUCTION SIDE SHALL BE DISTRIBUTED BY HARRINGTON AS PART NO. PBMEBB OR EQUAL. THE INSERT FITTING ON DISCHARGE SIDE SHALL BE HARRINGTON PART NO. PBMEBB OR EQUAL. STAINLESS WORM DRIVE HOSE CLAMPS SHALL BE PROVIDED TO TIE TUBINGS ON FITTINGS. CONTRACTOR SHALL PROVIDE A 1/2" THICK NEOPRENE ISOLATION DAMPNER FOR THE PUMP. 316 SS ANCHOR BOLTS SHALL BE PROVIDED TO ANCHOR PUMP AND BASE ON THE MOUNT LOCATION. PUMP MANUFACTURER SHALL PROVIDE OPERATION AND MAINTENANCE MANUAL.

7. N/A

8. N/A

9. CABLE TIES. BLACK NYLON CABLE TIES WITH SELF-LOCKING DEVICE. CABLE TIES SHALL HAVE A MINIMUM TENSILE STRENGTH OF 40 LB AND SHALL BE SUITABLE FOR OUTDOOR USE. CONTRACTOR SHALL TIE CHEMICAL FEED TUBINGS ON MIXER SUPPORT AT 2 FEET INTERVAL. CONTRACTOR SHALL PROVIDE 2" X 1/3" SLIT OPENINGS ON ANGLE BAR OF THE SUPPORT FOR TIGHTENING OF CABLE TIES AND TUBINGS ON THE ANGLE BAR. CABLE TIES SHALL ALSO BE PROVIDED AT 2" INTERVAL TO TIE DOWN SUCTION TUBING OF TRANSFER PUMP (23) TO THE TRAILER GRATING FLOOR.

10. LIGHT. 200 WATT INCANDESCENT LIGHTING FIXTURES ENCLOSED AND GASKETED FOR OUTDOOR USE.

11. REACTION TANK. THE 600 GALLON REACTION TANK SHALL BE MANUFACTURED IN ACCORDANCE WITH SHEET 4. TANK MATERIAL SHALL CONTAIN UV INHIBITOR AND SUITABLE FOR OUTDOOR USE.

12. ORP SENSOR AND CONTROLLER. SENSOR BODY SHALL BE CONSTRUCTED OF MOLDED CHEMICALLY RESISTANT TEFZEL IN A TITANIUM TUBE. THE SENSOR SHALL HAVE MEASURING RANGE OF -1400 TO +1400 MV. THE SENSOR SHALL BE A DISPOSABLE TYPE FOR MINIMIZING TROUBLESHOOTING AND MAINTENANCE DOWNTIME. THE ORP SENSOR SHALL BE MOUNTED ON THE RECIRCULATING PIPELINE AS SHOWN ON THE DESIGN DRAWINGS. THE CONTRACTOR SHALL PROVIDE REQUIRED TEE AND FITTINGS FOR SENSOR INSTALLATION. A PROCESS CONNECTOR SHALL ALSO BE PROVIDED FOR EASIER REMOVE THE ORP SENSOR. THE CONTRACTOR SHALL INSTALL THE ORP SENSOR TO ALLOW ELECTRODE OF THE SENSOR LOCATED AT CENTER OF PIPE FLOW LINE. THE SENSOR SHALL BE MADE BY ROSEMOUNT AS MODEL 3854-03-12 WITH PREAMPLIFIER OR EQUAL. THE CONTROLLER SHALL BE HOUSED IN A NEMA4X ENCLOSURE AND BE MOUNTED IN MAIN CONTROL PANEL. THE CONTROLLER SHALL HAVE A DOT-MATRIX LIQUID CRYSTAL DISPLAY, DUAL ISOLATED OUTPUTS, CONTINUOUS REFERENCE DIAGNOSTICS AND AUTOMATICALLY TEMPERATURE COMPENSATION. THE CONTROLLER SHALL REQUIRE 115 VOLT, 60 HZ POWER. THE CONTROLLER SHALL BE MANUFACTURED BY ROSEMOUNT AS MODEL 54-04-06 OR EQUAL. THE MANUFACTURER SHALL PROVIDE OPERATION AND MAINTENANCE MANUAL.

13. PH SENSOR AND CONTROLLER. SENSOR BODY SHALL BE CONSTRUCTED OF MOLDED CHEMICALLY RESISTANT TEFZEL IN A TITANIUM TUBE. THE SENSOR SHALL HAVE MEASURING PH RANGE OF 0 TO 14. THE SENSOR SHALL BE A DISPOSABLE TYPE FOR MINIMIZING TROUBLESHOOTING AND MAINTENANCE DOWNTIME. THE PH SENSOR SHALL BE MOUNTED ON THE RECIRCULATING PIPELINE AS SHOWN ON THE DESIGN DRAWINGS. THE CONTRACTOR SHALL PROVIDE REQUIRED TEE AND FITTINGS FOR SENSOR INSTALLATION. A PROCESS CONNECTOR SHALL ALSO BE PROVIDED FOR EASIER REMOVE THE PH SENSOR. THE CONTRACTOR SHALL INSTALL THE PH SENSOR TO ALLOW ELECTRODE OF THE SENSOR LOCATED AT CENTER OF PIPE FLOW LINE. THE SENSOR SHALL BE MADE BY ROSEMOUNT AS MODEL 3854-03-11 WITH PREAMPLIFIER OR EQUAL. THE PROCESS CONNECTOR SHALL BE ROSEMOUNT P/N 23166-00 OR EQUAL. THE ANALYZER SHALL BE HOUSED IN A NEMA4X ENCLOSURE AND BE MOUNTED IN MAIN CONTROL PANEL. THE CONTROLLER SHALL HAVE A DOT-MATRIX LIQUID CRYSTAL DISPLAY, DUAL ISOLATED OUTPUTS, CONTINUOUS PH AND REFERENCE DIAGNOSTICS AND AUTOMATICALLY TEMPERATURE COMPENSATION. THE CONTROLLER SHALL REQUIRE 115 VOLT, 60 HZ POWER. THE CONTROLLER SHALL BE MANUFACTURED BY ROSEMOUNT AS MODEL 54-04-06 OR EQUAL. THE MANUFACTURER SHALL PROVIDE OPERATION AND MAINTENANCE MANUAL.

14. REACTOR MIXER. MIXER WITH 1/3 HP DC MOTOR, SOLID STATE CONTROL UNIT, AND ANGLE PLATE. MIXING SPEED SHALL BE MANUALLY ADJUSTED THROUGH THE SOLID STATE CONTROL UNIT WITH MAXIMUM 350 RPM AND MINIMUM 70 RPM OR LESS. THE MIXER SHALL BE LIGHTNIN MODEL VSQ25SCR OR EQUAL AND THE SOLID STATE CONTROL UNIT SHALL BE LIGHTNIN SCR SERIES OR EQUAL. THE MIXER SHALL HAVE STAINLESS STEEL IMPELLER. THE IMPELLER SHALL BE LIGHTNIN A 310 OR EQUAL. THE MANUFACTURER SHALL PROVIDE OPERATION AND MAINTENANCE MANUAL.

15. MIXER SUPPORT. SEE DETAIL IN SHEET 4.

16. 1-1/2" DIAMETER SCHEDULE 80 PVC PIPES AND FITTINGS.

17. TRUE UNION BALL VALVE. 1-1/2" PVC BALL VALVE WITH VITON O RINGS. DISTRIBUTED BY HARRINGTON INC OR EQUAL.

18. QUICK CONNECTOR. 1-1/2" BLACK GLASS FILLED POLYPROPYLENE FEMALE COUPLER X FPT. HARRINGTON PART NO. BPP-015FL OR EQUAL.

19. BRAIDED VINYL TUBING. BRAIDED VINYL TUBING WITH 1-1/2" ID. NALGENE 980 OR EQUAL. CONTRACTOR SHALL PROVIDE 1-1/2" MALE COUPLER X HOSE QUICK CONNECTORS (HARRINGTON PART NO. CPP-015FL OR EQUAL) ON BOTH SIDES OF EACH TUBING.

20. FILTERS. FILTERS WITH INTERCONNECTION PIPES SHALL BE MADE BY AMETEK, INC MODLE #10 BY BLUE AS USED IN NAVSSES WASTEWATER RECYCLING UNIT WITH SIEVE OPENING SHOWN ON THE DESIGN DRAWINGS.

21. CHECK VALVE. 1-1/2" CHECK VALVE WITH BRONZE BODY AND BRONZE DISC. THE VALVE SHALL BE SUITABLE FOR VERTICAL LINE INSTALLATION. THREAD CONNECTIONS. STOCKHAM FIGURE B-319 OR EQUAL. CONTRACTOR SHALL PROVIDE BRASS FITTINGS FOR THE CONNECTION OF THE CHECK VALVE AND PUMP.

22. BRASS PIPING AND FITTINGS. BRASS PIPE SHALL CONFORM TO THE REQUIREMENTS OF FEDERAL SPECIFICATIONS WW-P-351C, GRADE A, STANDARD, OR ASTM DESIGNATION B-135-74, HARD-DRAWN. FITTINGS SHALL CONFORM TO THE REQUIREMENTS OF FEDERAL SPECIFICATION WW-P-460B; EXCEPT THAT UNIONS SHALL CONFORM TO THE REQUIREMENTS OF FEDERAL SPECIFICATION WW-U-516A.

23. TRANSFER PUMP. THE TRANSFER PUMP SHALL BE BURKES CENTRIFUGAL PUMP WITH 2 HP, 230 VAC, 1Ø, 3500 RPM, TEFC MOTOR. PUMP SHALL HAVE 40 GPM FLOW AT 89 FEET OF HEAD. PUMP OPERATION AND MAINTENENCE MANUAL SHALL BE PROVIDED.

24. TRAILER SHALL BE 2 AXLE TYPE WITH MINIMUM LOADING CAPACITY OF 6 TONS IN ACCORDANCE WITH SHEET 5. TRAILER TIRE AND WHEEL ASSEMBLY SHALL BE CAPABLE OF MEETING MINIMUM LOAD RANGE E REQUIREMENTS. TRAILER SHALL BE EQUIPPED WITH 3 TRAILER JACKS, EACH WITH 3000 LBS. CAPACITY. ASSEMBLY SHALL HAVE A MINIMUM SPEED RATING OF 30 MPH AND DESIGNED FOR INDUSTRIAL USE.

25. ROTAMETER. THE ROTAMETER SHALL BE AN ACRYLIC TUBE WITH STAINLESS STEEL FLOAT AND PVC END FITTINGS. IT SHALL HAVE A RANGE OF 0-40 GPM. END FITTINGS SHALL BE 1-1/2" MNPT AND MAXIMUM HEIGHT OF TUBE 12-1/16".

26. CONTROL PANEL. FLOOR MOUNTED CONTROL PANEL WITH APPROXIMATELY DIMENSION OF 3'0" X 2'4" X 1'4". THE CONTROL PANEL SHALL BE FULLY ENCLOSED IN A LOCKING, WEATHER PROOF METAL CASE CONSISTING OF STEEL FRAME WITH RIGID STEEL PANELS. CONNECTIONS OF THE CONTROL PANEL TO THE TRAILER SHALL BE CAPABLE OF RESISTING 40 MPH WIND LOAD. PROVIDE FACTORY PAINT FOR THE ENCLOSURE.

27. STORAGE CABINET. FLOOR STORAGE CABINET SHALL BE FULLY ENCLOSED IN A LOCKING NEMA 4 STEEL CASE WITH APPROXIMATELY DIMENSION OF 3'0" X 2'6" X 1'4". THE CABINET SHALL HAVE TWO STEEL MOUNTING PLATES WITH MAXIMUM 3" ADJUSTABLE MOUNTING INTERVALS. CONNECTIONS OF THE STORAGE CABINET TO THE TRAILER SHALL BE CAPABLE OF RESISTING 40 MPH WIND LOAD. PROVIDE FACTORY PAINT FOR THE CABINET.

28. MINI ZONE POWER ENTER. SEE SHEET 3.

29. N/A

30. FIRE EXTINGUISHER. FIRE EXTINGUISHER SHALL BE D.O.T. APPROVED WITH VEHICLE MOUNTING BRACKET AND NOZZLE DISCHARGE. THE FIRE EXTINGUISHER SHALL BE SUITABLE USED FOR ELECTRICAL FIRE. THE FIRE EXTINGUISHER SHALL BE SUPPLIED BY MCMASTER OR EQUAL.

31. 1/4" PVC SAMPLE TAP WITH VALVE.

32. PROGRAMMABLE LOGIC CONTROLLER (PLC) SHALL BE ALLEN-BRADLEY SLC-5/04.

33. SAFETY SWITCH BOX - SQUARE D, CAT. NO. 00235.

34. CONTRACTOR SHALL PROVIDE ALL THE FITTINGS, HOSES, TUBINGS, AND PIPES WHICH ARE NOT SPECIFIED IN THE SPECIFICATION, BUT ARE REQUIRED TO COMPETE THE INSTALLATION OF THIS TRAILER MOUNTED TREATMENT UNIT AS SHOWN ON THE DESIGN DRAWINGS.

35. BULKHEAD FITTING. 1 1/2" SCHEDULE 80 PVC. HARRINGTON PART NO. 151-015 OR EQUAL.

36. QUICK CONNECTOR. 1/2" BLACK GLASS FILLED POLYPROPYLENE MALE AND FEMALE CONNECTOR X INSERT (HOSE BARB). HARRINGTON PLASTICS PART NO. CPP-005LF AND EPP-005LF OR EQUAL.

37. GFI RECEPTICLE MOUNTED BEHIND FRP CONTAINER, TYP. OF 4.

38. NEOPRENE ISOLATION DAMPNER. 6" X 12" X 1/2" THICK, TYP. OF 4.

39. STEEL, NEMA 3 RATED ENCLOSURE W ADJUSTABLE SHELVING AND LOCKING DOORS. SEE SHEET 4.

40. POLYPROPYLENE LINING FOR THE BOTTOM 8" OF EACH COMPARTMENT OF ITEM 39. LINING SHALL BE COMPLETELY WATERTIGHT WITH A 1/2" DRAIN MOLDED OR PLASTIC WELDED INTO THE BOTTOM OF THE LINING EXTENDING THROUGH THE ENCLOSURE. LINING SHALL BE PERMANENTLY ADHERED TO ENCLOSURE.

41. GASKETED WALL PENETRATION. PROVIDE NEOPRENE GASKETED PENETRATION FOR PUMP POWER CORD. TYPICAL OF 4.

42. ONE PIECE MOLDED FIBERGLASS CONTAINMENT WITH DIMENSIONS 31-3/4" L X 19-1/4" W X 4"H. WHITE COLOR. MCMASTER-CARR 47381T OR EQUAL.

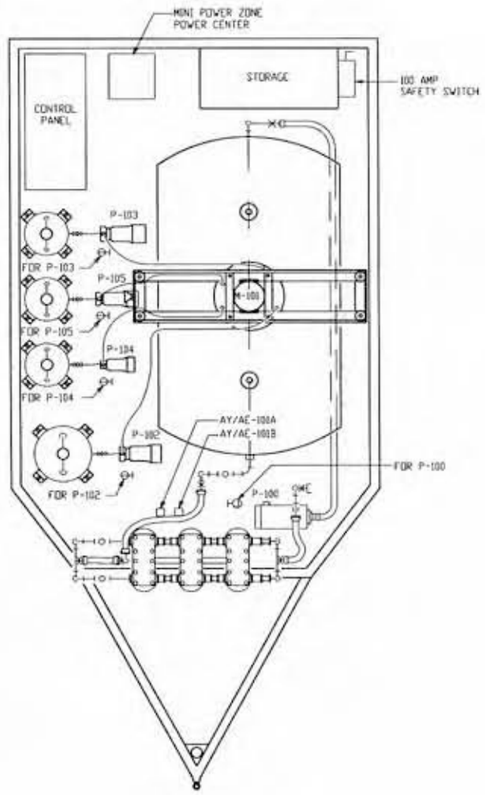
SIZE	FSCM NO.	ESWBS	DWG NO.	REV
B				
SCALE			SHEET 2	

Figure 3-9 NWTS General Notes - Shee 2

DWG. NO.	SH	REV

REVISIONS

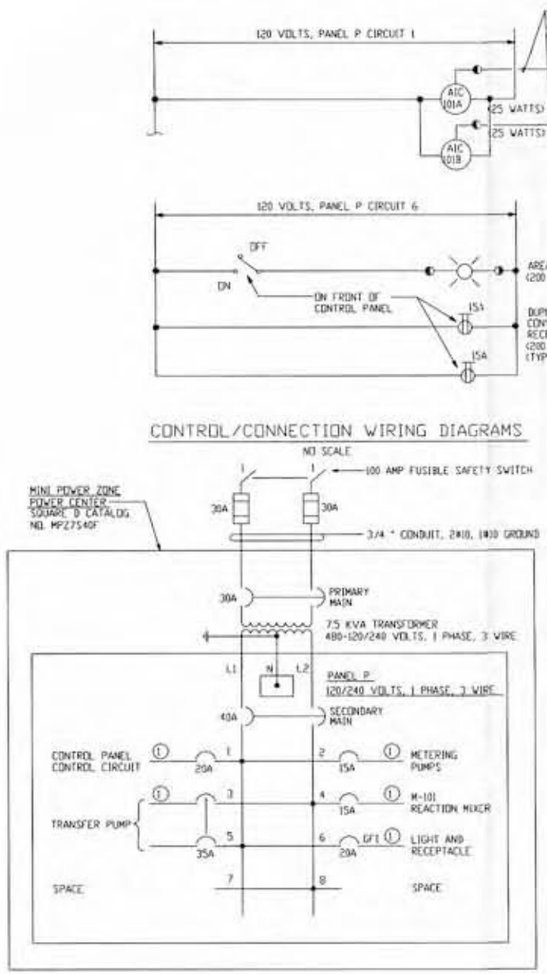
ZONE	REV	DESCRIPTION	DATE	APPROVED



ELECTRICAL PLAN

3/4 "=1'-0"

CONTRACTOR SHALL PROVIDE ALL CIRCUITING INDICATED ON THE SINGLE LINE DIAGRAM, CONTROL/CONNECTION WIRING DIAGRAMS AND PROCESS AND INSTRUMENTATION DIAGRAMS (SHEET 1-2) BETWEEN TRAILER MOUNTED DEVICES AND THE CONTROL PANEL AND THE MINI POWER ZONE POWER CENTER. CIRCUITING SHALL BE IN RIGID STEEL CONDUIT(S). MINIMUM SIZE CONDUCTORS SHALL BE NO. 12AWG. INSTALLATION SHALL COMPLY TO NATIONAL ELECTRICAL CODE REQUIREMENTS.

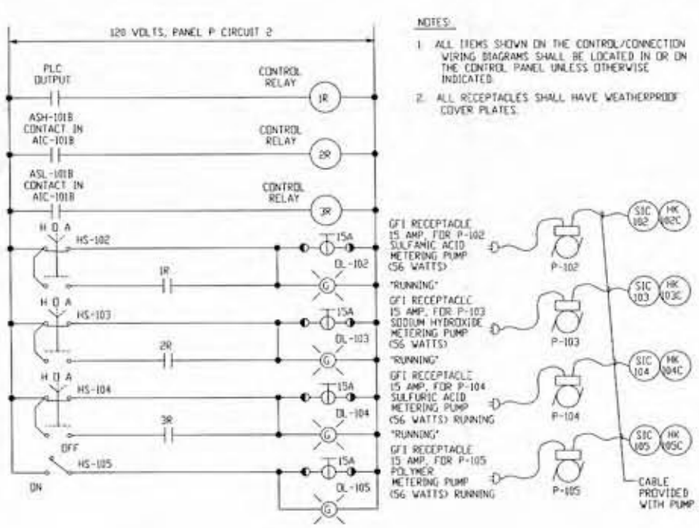


Ⓔ SEE CONTROL/CONNECTION WIRING DIAGRAMS FOR CONTINUATION

SINGLE LINE DIAGRAM

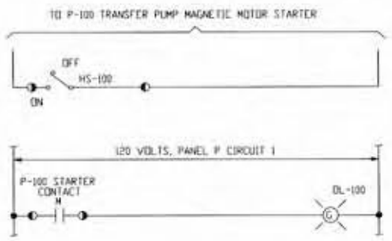
NO SCALE

CONTROL/CONNECTION WIRING DIAGRAMS

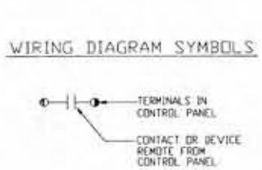


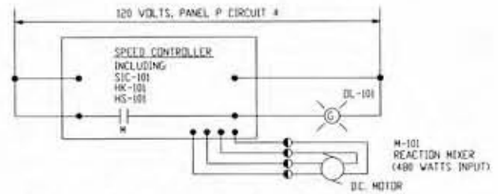
NOTES:

1. ALL ITEMS SHOWN ON THE CONTROL/CONNECTION WIRING DIAGRAMS SHALL BE LOCATED IN OR ON THE CONTROL PANEL UNLESS OTHERWISE INDICATED.
2. ALL RECEPTACLES SHALL HAVE WEATHERPROOF COVER PLATES.



WIRING DIAGRAM SYMBOLS





CONTROL/CONNECTION WIRING DIAGRAMS

NO SCALE

SIZE	FSCM NO.	ESWBS	DWG NO.	REV
B				
SCALE			SHEET 3	

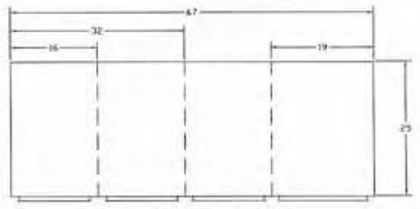
Figure 3-10 NWTS Wiring Diagram - Sheet 3

DWG. NO.	SH	REV

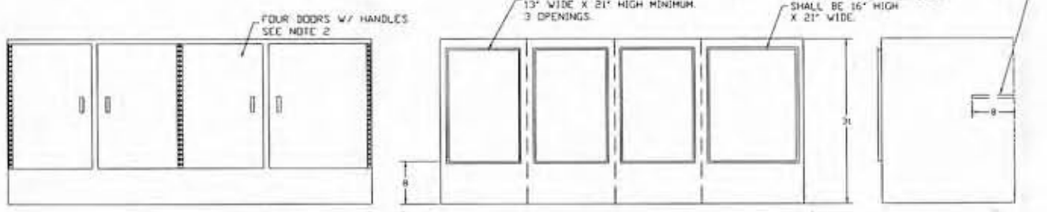
REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

ENCLOSURE NOTES:

1. INDUSTRIAL ENCLOSURE, STEEL, NEMA TYPE 3 RATED.
2. ENCLOSURE SHALL CONTAIN FOUR (4) GASKETED PROJECTION TYPE DOORS, ONE FOR EACH OPENING. DOORS SUPPORTED BY HEAVY GAUGE CONTINUOUS HINGES. DOORS SHALL OPEN OUTWARD, CONTAIN HANDLES AND BE LOCKABLE.
3. ENCLOSURE AND ALL PANELS SHALL BE MADE OF 12 GAUGE STEEL. SEAMS SHALL BE CONTINUOUSLY WELDED AND GROUND SMOOTH, INCLUDING PARTITIONS BETWEEN COMPARTMENTS. ENCLOSURE SHALL HAVE NO HOLES OR KNOCKOUTS.
4. GRAY POLYURETHANE CORROSION RESISTANT FINISH INSIDE AND OUT.
5. EACH COMPARTMENT SHALL CONTAIN A SHELF THAT IS ADJUSTABLE IN HEIGHT, AND EXTENDS FROM THE REAR OF THE COMPARTMENT OUT EIGHT (8) INCHES. SHELF SHALL BE CONSTRUCTED OF 12 GAUGE STEEL.



TOP VIEW - FRAME

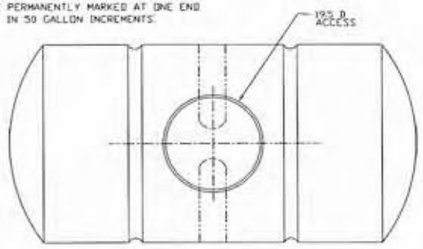


FRONT VIEW - ASSEMBLY | FRONT VIEW - FRAME (WITHOUT DOORS INSTALLED) | SIDE VIEW

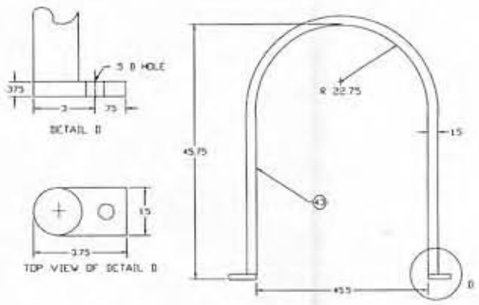
ENCLOSURE DETAILS

NOTES FOR TANK:

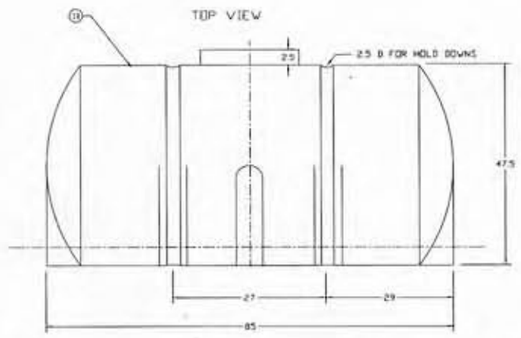
1. TANKS SHALL BE 600 GALLON CAPACITY.
2. TANKS SHALL BE SELF-STANDING WITH GROOVES FOR SUPPORT BRACKETS.
3. TANKS SHALL BE SEMI-TRANSPARENT TO ALLOW FOR LEVEL INDICATION.
4. LIDS SHALL BE PROVIDED FOR MAIN TOP OPENINGS THAT ARE SECURABLE TO TANK.
5. TANKS SHALL BE BAFFLED, HOWEVER HUMAN ACCESS MUST BE ALLOWED IN ALL PORTIONS OF THE TANK INTERIOR.
6. TANK SHALL BE PERMANENTLY MARKED AT ONE END TO SHOW CAPACITY IN 50 GALLON INCREMENTS.



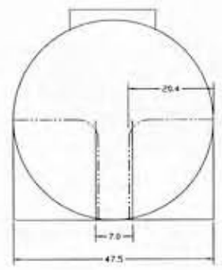
TOP VIEW



TIE DOWN RING SPECIFICATIONS

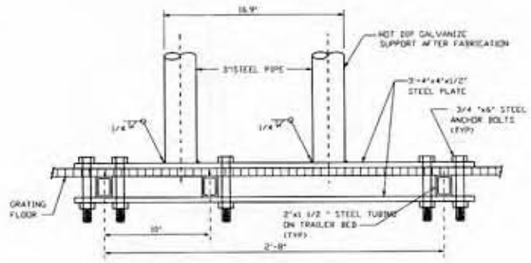


FRONT VIEW

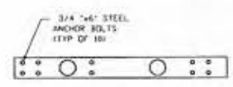


SIDE VIEW

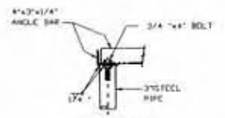
REACTION TANK DETAILS



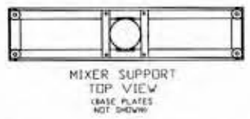
MIXER SUPPORT MOUNTING

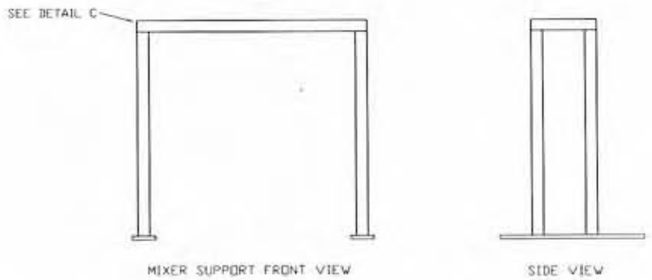


MIXER SUPPORT BASE DETAILS



DETAIL C


MIXER SUPPORT TOP VIEW (BASE PLATES NOT SHOWN)



MIXER SUPPORT FRONT VIEW | SIDE VIEW

MIXER SUPPORT DETAILS

ITEM NO	QTY	DESCRIPTION	MATERIAL	MATL SPEC	REMARKS	REF DWG
2	43	TIE DOWN RING, SCHD 80 PIPE, 1.5" NOMINAL SIZE.	GALVANIZED IRON		2 REQD FOR UNIT, 2 PER TANK	
1	11	600 GALLON HORIZONTAL HOLDING TANK.	HD CROSSLINK POLYETHYLENE	ASTM D2647	1 TANKS PER UNIT.	

TANK PART SPECIFICATIONS

SIZE	FSCM NO.	ESWBS	DWG NO.	REV
B				
SCALE			SHEET 4	

Figure 3-11 NWTS Tank and Enclosure Details - Sheet 4

DWG. NO.	SH	REV

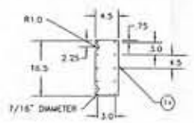
REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

NOTES FOR TRAILER:

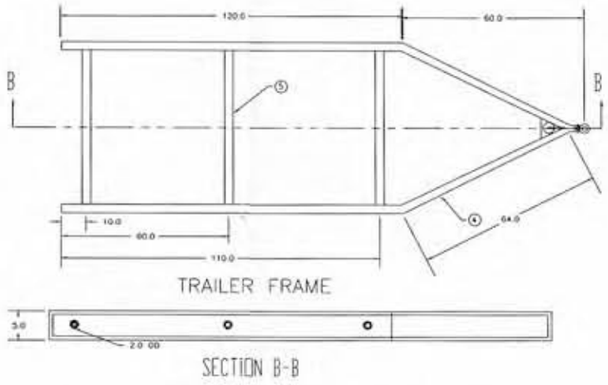
1. SURFACE PRESERVATION OF ALL EXPOSED METAL PARTS SHALL BE IN ACCORDANCE WITH NSTM S9086-VD-STM-000 CH. 631. TYPICAL PRIMER IS 1 COAT FORMULA-84, TT-P-6458, 1.5 MILS THICK. TYPICAL FINISH COAT IS 1 LAYER FORMULA 111, MIL-E-15090, 1.5 MILS THICK. YELLOW COLOR.

2. TRAILER DECK SHALL BE SECURED TO TRAILER BED, TRAILER BED TO TRAILER FRAME, AND TRAILER FRAME TO AXLE ASSEMBLY AT ALL CONTACT POINTS BY WELDING IN ACCORDANCE WITH COMMERCIAL WELDING SPECIFICATIONS.

3. ASSEMBLY SHALL HAVE A MINIMUM SPEED RATING OF 30 MPH AND DESIGNED FOR INDUSTRIAL USE. IT SHALL NOT BE SUPPLIED WITH ACCESSORIES FOR STREET USE. (I.E. BRAKES, LIGHTS, ETC).

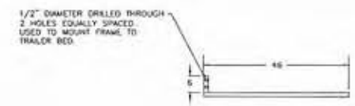


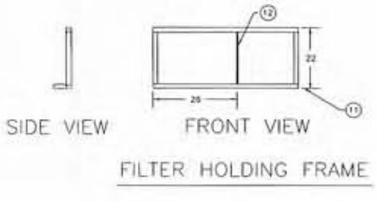
CARTRIDGE FILTER BRACKET



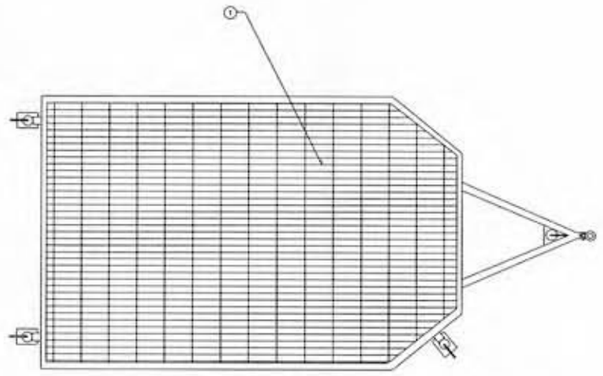
TRAILER FRAME

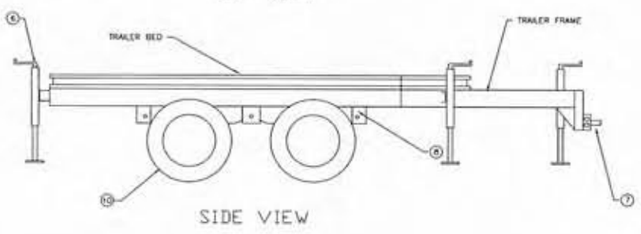
SECTION B-B



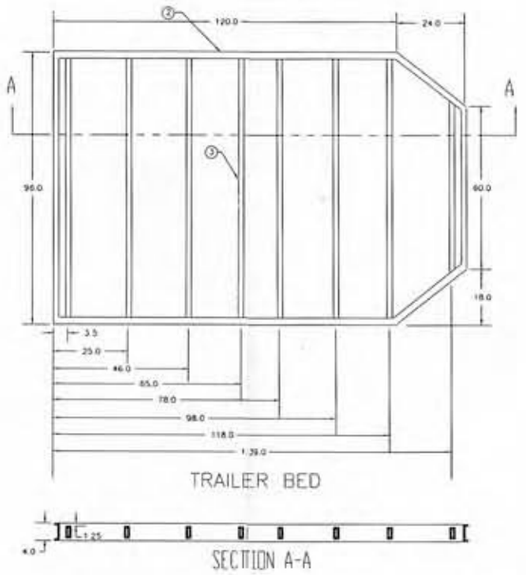


FILTER HOLDING FRAME





TRAILER ASSEMBLY



TRAILER BED

SECTION A-A

NO REQ	PC NO	DESCRIPTION	MATERIAL	MATL SPEC	REMARKS	REF DWG
3	14	CARTRIDGE FILTER BRACKET	CARBON STEEL			
	13					
	12	1-1/4" x 1/4" STEEL STOCK				
	11	1-1/2" x 1-1/2" x 1/4" ANGLE IRON				
4	10	TIRE AND WHEEL ASSEMBLY COMPATIBLE WITH ITEM 9			TIRE SIZE: 8-14.5; MINIMUM LOAD RANGE E	
	9					
1	8	TANDEM AXLE ASSEMBLY			8 TON CAPACITY 30 MPH MIN SPEED RATING	
1	7	ADJUSTABLE HEIGHT TOWING LUNETTE			20" TO GROUND AT LOWEST SETTING	
4	6	TRAILER JACKS			3000 LB CAPACITY EACH	
	5	2" STRUCTURAL STEEL PIPE				
	4	5" CHANNEL IRON FRAME				
	3	1-1/2" BY 2" STRUCTURAL STEEL TUBING				
	2	4" CHANNEL IRON FRAME				
8	1	1-1/4" THICK METAL BAR TYPE GRATING, MIL PER MIL-G-6513E CLASS 1, TYPE 1, MATL 6	GALVANIZED STEEL			

TRAILER PART LIST

SIZE	FSCM NO.	ESWBS	DWG NO.	REV
B				
SCALE			SHEET 5	

Figure 3-12 NWTS Trailer Layout - Sheet 5

DWG NO.	SH	REV

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

FUNCTION SYMBOL SCHEDULE					
LETTER	FIRST LETTER		SUCCEEDING LETTERS		
	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
C	CONDUCTIVITY (ELECTRICAL)			CONTROL	CLOSE
H	HAND (MANUALLY INITIATED)				HIGH
I	CURRENT (ELECTRICAL)		INDICATE		
K	TIME OR TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT (PILOT)		LOW
M	MOTOR	MOMENTARY			MID
O	OPERATION	OFFSET	ORIFICE (RESTRICTION)		OPEN
P	PRESSURE OR VACUUM				
S	SPEED OR FREQUENCY	SAFETY		SWITCH	

LINE CODES

LINE CODES

- SIGNAL LINE (ELECTRICAL, DIGITAL, OR ANALOG)
- PROCESS OR MECHANICAL LINE
- PNEUMATIC LINE
- CAPILLARY
- SONIC OR RF SIGNAL

LINE CODES (CONT'D)

- NO CONNECTION
- CONNECTIONS
- DATA HIGHWAY COMMUNICATIONS LINK
- HEAT TRACING
- HYDRAULIC

CODES AND ABBREVIATIONS

CODES AND ABBREVIATIONS

SYMBOLS TO THE ABOVE RIGHT OF HS BALLOON ARE DEFINED AS FOLLOWS:

H/A = HAND-OFF-AUTO	L/S = LOCKOUT-STOP
D/S = DUTY-STANDBY	L/L = LEAD-LAG
O/C = OPEN-STOP-CLOSE	L/R = LOCAL/REMOTE
O/C = OPEN-CLOSE	S/S = START-STOP
O/O = ON-OFF	

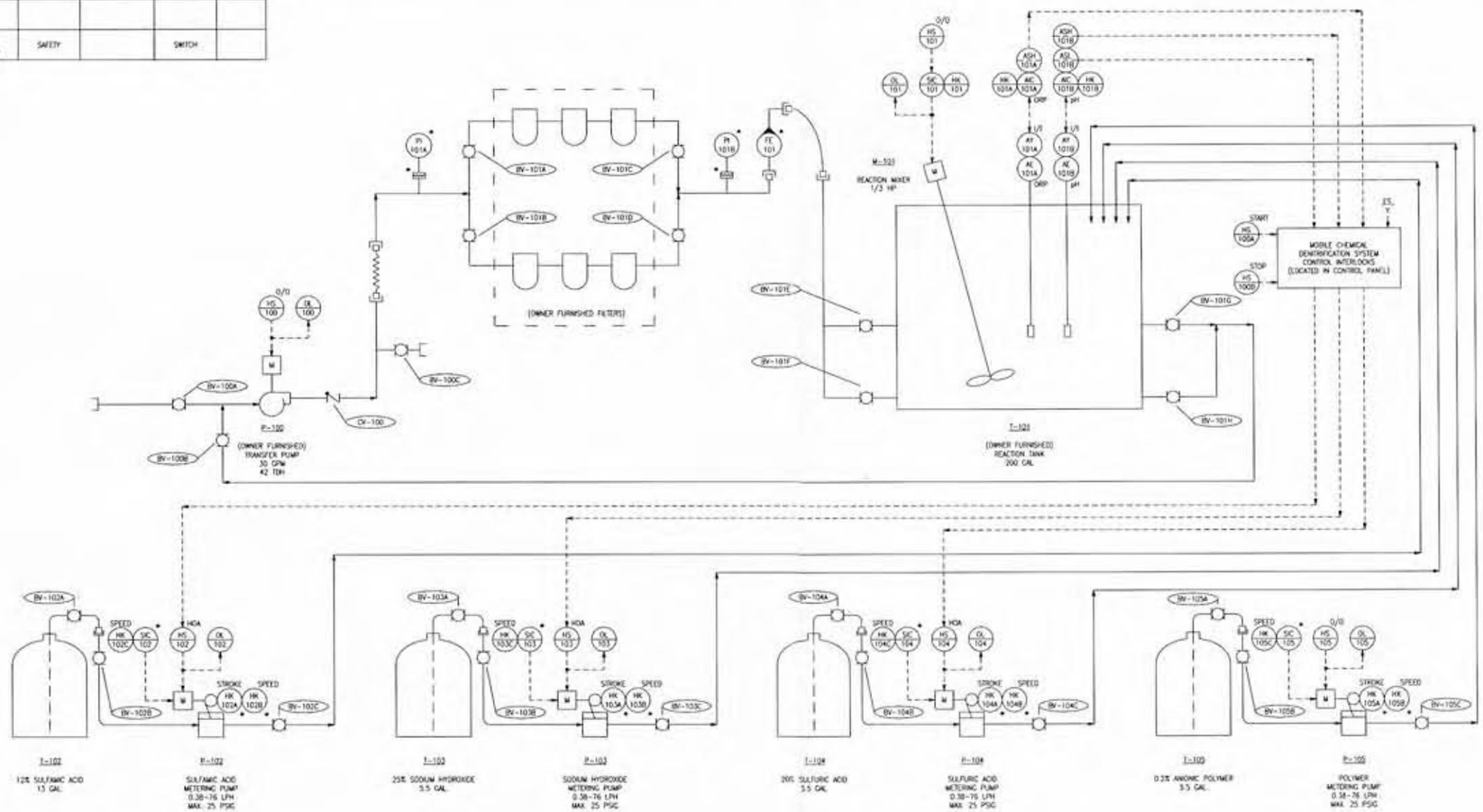
ITEMS MARKED ★ ARE INTEGRAL PART OF MECHANICAL EQUIPMENT FURNISHED

TYPICAL TAG NUMBER CODING SYSTEM

BASIC SYMBOLS

BASIC SYMBOLS

- FIELD MOUNTING
- FACE MOUNTED ON MAIN CONTROL PANEL
- MANUALLY OPERATED VALVES, REF. ONLY
- CHECK VALVE (FLOW DIRECTION)
- HOSE COUPLING
- BALL VALVE
- CENTRIFUGAL PUMP
- MOTOR ACTUATOR
- ROTAMETER
- MIXER



SIZE	FSCM NO.	ESWBS	DWG NO.	REV
B				
SCALE			SHEET 6	

Figure 3-13 NWTS Process and Instrumentation Diagram (P&ID) - Sheet 6

SECTION 4

SAFETY PLAN

4.1 OBJECTIVES

The purpose of this safety plan is to provide a document that will establish personnel protection standards and safety practices to operate the mobile Nitrite Wastewater Treatment System (NWTS). The provisions of this plan are recommended to safely operate the NWTS. All personnel who operate or maintain the NWTS must review and sign the plan acceptance. Personnel must be familiar with this plan and comply with its requirements. In addition to the safety procedures established in this plan, the general safety standards of the Navy base or facility must also be followed.

The safety plan includes the following topics:

- Operator training and medical monitoring requirements
- Safety and health risk analysis
- Site emergency response plan, emergency contacts list, and a map showing the route from the facility to the nearest hospital
- Specific operation requirements for levels of protection
- Accident Report Form
- Safety Plan Acceptance Form.

An example of site specific information for preparing a safety plan at SIMA San Diego is shown in Table 4-1. Table 4-2 illustrates an example Safety Plan Acceptance Form for operators working on the mobile Nitrite Wastewater Treatment System.

4.2 OPERATOR TRAINING AND ADDITIONAL TRAINING REQUIREMENTS

All operators must have 40-hours of Occupational Safety and Health Act (OSHA) approved training as specified in 29 CFR 1910.120(e) and a current 8-hour annual refresher course. All operators will participate in an appropriate and current medical monitoring program. In addition, all operators must be familiar with the contents of this plan. Listed below are additional health and safety training and medical monitoring requirements for the mobile NWTS operations.

4.2.1 Additional Safety Training Requirements

All personnel engaged in supervisory position will have completed 40-hours OSHA approved training and the 8-hour OSHA supervisory training as specified in 29

Table 4-1

SAFETY PLAN SITE SPECIFIC INFORMATION

Fire Department, Paramedics
Telephone Number: 9-911 OR 556-8899
Radio Frequency: N/A

Naval Facility Safety Officer
Name: Tom Dowdy
Title: SIMA Safety Manager
Code: 0020
Business Telephone Number: 556-2948
On-Call Telephone Number: 556-1500

Emergency Medical Services
Name of Facility: Naval Medical Facility
Facility Address: Naval Station 32nd St., San Diego, CA 92136
Facility Telephone Number: 9-911 or 556-8114
Facility Radio Frequency: N/A
Facility Map Showing Route to Facility:
(attach the map)

Local Hospital (if different from above)
Name of Facility: Balboa Naval Hospital
Facility Address: Naval Medical Center, San Diego, CA 92134-5000
Facility Telephone Number: 9-911 or 556-8114
Facility Radio Frequency: N/A
Facility Map Showing Route to Facility: N/A

Emergency Response Team (Spills and Fire)
Name of Facility: Federal Fire Department
Facility Address: Naval Training Center, San Diego, CA 92133
Facility Telephone Number: 9-911 or 6-8899
Facility Radio Frequency: N/A

County Poison Information Center
Name of Facility: San Diego Poison Control Center
Facility Telephone Number: 543-6000

Table 4-2

SAFETY PLAN ACCEPTANCE FORM

PROJECT HEALTH AND SAFETY PLAN

Instruction: This form is to be completed by each person to work on the mobile Nitrite Wastewater Treatment System (NWTS) and return to the safety officer.

I have read and agree to abide by the contents of the Health and Safety Plan for the following Project:

Mobile Nitrite Wastewater Treatment System

_____

Signed

_____

Date

RETURN TO:

Navy Facility Health and Safety Officer

CFR 1910.120(e). All personnel engaged in the operation of the mobile NWTS must be thoroughly briefed on the site-specific anticipated hazards, equipment to be worn, safety practices to be followed, emergency procedures, and communications.

4.2.2 Additional Training Requirements

All operators should meet requirements as specified in "OPNAV Instruction 4110.2" for additional training recommendations, storage and labeling requirements for hazardous materials and transportation requirements.

4.3 SAFETY AND HEALTH RISK ANALYSIS

4.3.1 Chemical Hazards

Chemicals used for the NWTS include 10 percent sulfamic acid, 10 percent sulfuric acid, 20 percent sodium hydroxide, and polymer. Exposure of these chemicals may cause severe eye and skin irritation or burns. Operators should read each Material Safety Data Sheets (MSDS) and become familiar with the hazards of these chemicals before starting work on the NWTS.

The untreated wastewater contains sodium nitrite and heavy metals such as cadmium, chromium, copper, iron, lead, nickel, and zinc. Ingestion of nitrite may interfere with hemoglobin acting as an oxygen carrier in the blood. Anoxia and death may then occur. Heavy metals in the human body act as carcinogens and may cause a variety of organ disorders.

4.3.2 Physical Hazards

4.3.2.1 Heat Stress

Potential heat stress (see Section 4.5.3).

4.3.2.2 Material Lifting

Handling of heavy or bulk items such as chemical drums requires caution because they can cause accidents. The proper lifting of materials to avoid back injuries calls for routine conformance with the following fundamentals:

- Consider the size, shape, and weight of the object to be lifted and lift only what can be handled comfortably.
- Inspect the item for metal slivers, jagged edges, burrs, and rough or slippery surfaces.

- Use solid footing and place feet far enough apart for good balance and stability.
- Move as close to the load as possible and bend the legs about 90 degree at the knees.
- Keep the back as straight as possible.
- Grip the object firmly.
- To lift the object, straighten the legs from their 90-degree bend.
- Never carry a load that blocks forward vision.
- When lowering an object, repeat the stance and position for lifting. Bend the legs to 90 degree at the knees and lower the object.
- When two or more persons are required to handle the object, coordinate the effort to ensure a smooth lift and equal distribution of the weight among the lifters. When carrying the object, each person, if possible, should face the direction of travel.

4.3.3 Electrical Hazards

The power source for the NWTS is 480 volt, 3 phase, with a full load amperage of 30 amps. Use insulated tools and wear approved electrical protective gloves and insulated shoes to prevent electrical shock during power connection. Minimum standard for the gloves shall be ASTM D-120, Type I, Class 0. Operators shall follow all electrical safety requirements as specified in "NSTM Chapter 300 Section 2" to safely operate the NWTS.

4.4 EMERGENCY RESPONSE PLAN

During operations, risk is minimized by establishing good work practices, staying alert, and using proper personal protective equipment. Unpredictable events such as physical injury, chemical exposure, or fire may occur and must be anticipated. Operators are encouraged to participate in annual Red Cross first aid and Cardio Pulmonary Resuscitation (CPR) courses to effectively handle physical and medical emergencies that may arise during operations.

4.4.1 Guidelines for Pre-Emergency Planning and Training

Operators must read the operations manual and the safety plan, and must familiarize themselves with the information in this chapter. Operators will be required to have a copy of the emergency contacts and phone numbers immediately accessible on the Naval facility and to know the route to the nearest emergency medical services.

4.4.2 Emergency Recognition and Prevention

Emergency conditions are considered to exist if:

- Any member of the operation crew is involved in an accident;
- Spill of chemicals;
- Rupture of reaction tank;
- Fire; and
- Traffic Accident.

Some ways of preventing emergency situations are listed below.

- Inspect chemical containers, reaction tank, and pipes and fittings conditions before moving or operating the unit.
- Handle chemicals in accordance with their Material Safety Data Sheets (MSDS) and the Operations Manual.
- All operators should make use of their senses (all senses) to alert themselves to potentially dangerous situations which they should avoid, e.g., never handle electrical equipment with wet hands.
- Operators should practice unfamiliar operations before using the actual chemicals, e.g., perform dry runs.
- Operators shall be familiar with the limitation of the equipment, such as:
  - Maximum wind load to the NWTS is 30 mph.
  - Cap chemical containers during transportation.
  - The chemical containers can't withstand excessive heat. Excessive heat may be produced during chemicals preparation.

In the event that an accident occurs, the operator should complete an Accident Report Form attached at the end of this section. Follow-up action should be taken to correct the situation that caused the accident.

General emergency procedures and specific procedures for handling personal injury and chemical exposure are described in the following sections.

4.4.3 Operator Roles, Lines of Authority, and Communication Procedures During Emergency

When an emergency occurs, decisive action is required. Rapidly made choices may have far-reaching, long-term consequences. Delays of minutes can create life-

threatening situations. Operators must be ready to respond to emergency situations immediately. All personnel should know their own responsibilities during an emergency, know who is in charge during an emergency, and the extent of their authority. This section outlines personnel roles, lines of authority, and communication procedures during emergencies.

In the event of an emergency situation during operations, the shift foreman will assume total control and will be responsible for on-site decision making. The shift foreman will also be responsible for coordinating all activities until emergency response teams (ambulance, fire department, etc.) arrive on-site.

The shift foreman will ensure that the Naval facility Health and Safety Officer and agencies are contacted as soon as possible after the emergency occurs. All operators must know the location of the nearest phone and the location of the emergency phone contact list and the location of the nearest hospital or medical center.

4.4.4 Emergency Site Security and Control

In an emergency situation such as chemical spill or fire, contain the spill or try to extinguish the fire using the fire extinguisher installed on the trailer, cordon off the area, and call emergency response teams. In an emergency situation, only necessary rescue and response personnel should be allowed into the NWTS operation area.

4.4.5 Procedures for Emergency Medical treatment and First Aid

4.4.5.1 Chemical Exposure

In the event of chemical exposure (skin contact, inhalation, ingestion), the following procedures should be implemented:

- Precautions should be taken to avoid exposure of other individuals to the chemical.
- If the chemical is on the individual's clothing, the clothing should be removed if it is safe to do so.
- If the chemical has contacted the skin, the skin should be washed with large amounts of water, preferably under a shower.
- In case of eye contact, an emergency eye wash should be used. Eyes should be flushed for at least 15 minutes.
- If necessary, the victim should be transported to the nearest hospital or medical center. If necessary, an ambulance should be called to transport the victim.

4.4.5.2 Personal Injury

In the event of personal injury:

Call 9-911.

Operators trained in first aid should administer treatment to an injured worker.

The victim should be transported to the nearest hospital or medical center. If necessary, a paramedic should be called to transport the victim.

The shift foreman is responsible for the completion of an Accident Report Form. An example of the form is shown in Table 4-3.

4.4.5.3 Fire

Disconnect the power source immediately if smoke or fire is observed. Try to extinguish the fire using the fire extinguisher installed on the trailer mounted unit. Inform the Fire Department and report to the appropriate safety officer.

4.4.5.4 Spill

Emergency conditions resulting from accidental spillage of untreated wastewater and chemicals must be handled immediately. Make proper repairs to stop the spill, contain the spill, and then report to the appropriate safety officer. A spill response team should be mobilized to clean up the spill.

For a minor spill emergency, the operator can use equipment as specified in Section 5.5.3 to clean up the spill.

4.4.5.5 Traffic Accident

Inspect the system immediately after a collision occurs. Ensure that the accident did not cause cracks or damage to the trailer tank, containers, pipes, and fittings. Make proper repairs to stop the leak. If the damage can not be repaired on site, immediately shut down the system (if operating), notify emergency response team, contain the spill and cordon off the spill area. After all repairs due to accidents, the NWTS should be tested for leaks using fresh water prior to the addition of wastewater to the system.

4.4.5.6 Emergency Contact

In the event of any situation or unplanned occurrence requiring assistance, the appropriate contact(s) should be made from the following site specific information. For emergency situations, telephone or radio contact should be made with the site point of contact or site emergency personnel who will then contact the appropriate response

Table 4-3

ACCIDENT REPORT FORM

Project: _____

NAVAL STATION

1. Name _____

2. Mail Address _____
(No. and Street) (City or Town) (State)

3. Location, if different from mail address _____

_____

INJURED OR ILL EMPLOYEE

4. Name _____ Social Security Number_____
(First) (Middle) (Last)

5. Home address _____
(No. and Street) (City or Town) (State)

6. Age _____ 7. Sex: Male_____Female_____(Check one)

8. Position _____
(Specific job title, not the specific activity he/she was performing at time of injury)

9. Department _____
(Enter name of department in which injured persons is employed, even though he/she may have been temporarily working in another department at the time of injury)

THE ACCIDENT OR EXPOSURE TO OCCUPATIONAL ILLNESS

10. Place of accident or exposure_____
(No. and Street) (City or Town) (State)

11. Was place of accident or exposure on premises of the Naval Station? (Yes/No)

12. What was the employee doing when injured?_____
(Be specific - If he/she was using

_____
tools or equipment or handling material, name and tell what he/she was doing.)

Table 4-3

ACCIDENT REPORT FORM
(Continued)

13. How did the accident occur? _____
(Describe fully the events which resulted
_____
in the injury or occupational illness. Tell what happened and how. Name
_____
any objects or substances involved. Give details on all factors which led
_____
to accident. Use separate sheet for additional space.)

14. Time of accident:_____

15. WITNESSES TO _____ _____ _____
(Name) (Affiliation) (Phone No.)

ACCIDENT _____ _____ _____
(Name) (Affiliation) (Phone No.)

_____ _____ _____
(Name) (Affiliation) (Phone No.)

OCCUPATIONAL INJURY OR OCCUPATIONAL ILLNESS

16. Describe the injury or illness in detail and indicate the part of body affected.
_____
_____

17. Name the object or substance which directly injured the employee. (For example, the machine or thing or struck against or which struck him/her; the vapor or poison he/she inhaled or swallowed; the chemical or radiation which irritated his/her skin; or in cases of strains, hernias, etc., the thing he/she was lifting, pulling, etc.)

_____

_____

18. Date of injury or initial diagnosis of occupational illness_____
(Date)

19. Did employee die?_____ (Yes or No)

OTHER

20. Name and address of physician _____

Table 4-3

ACCIDENT REPORT FORM
(Continued)

21. If hospitalized, name and address of hospital _____

_____

Date of report _____ Prepared by _____

Official position _____

teams. A map to show the route to emergency medical services for the NWTS operation at the activity should be attached for emergency use.

4.5 LEVELS OF PROTECTION AND PERSONAL PROTECTIVE EQUIPMENT REQUIRED FOR OPERATIONS

4.5.1 Personal Protective Equipment

Based on the potential hazards associated with operation of the NWTS, the following level of personal protection must be used to operate the NWTS.

Location	Job Function	Level of Protection
Varies	Operations	D Modified

Specific protective equipment for level of protection D Modified is as follows:

Level D Modified	Hard hat Steel toe and shank boots Splash-proof full face safety shield (chemical preparation) ASTM D-120, Type I, Class 0 gloves (power connection) Safety glasses Chemical resistant gloves Tivex or other protective clothing

NO CHANGES TO THE SPECIFIED LEVELS OF PROTECTION SHALL BE MADE WITHOUT THE APPROVAL OF THE FACILITY HEALTH AND SAFETY OFFICER.

4.5.2 Equipment Needs

Each operations team shall have the following items readily available:

- Copy of site health and safety plan including a separate list of emergency contacts
- First aid kit
- Fire extinguisher
- Eye wash bottle
- Paper towels
- Duct tape
- Water
- Plastic garbage bags
- Spill Response Bag
- Broom
- Dust Pan

4.5.3 Heat Stress

Adverse weather conditions are important considerations in planning and conducting outdoor operations. Hot or cold weather can cause physical discomfort, loss of efficiency, and personal injury. Of particular importance is heat stress, resulting when protective clothing decreases natural body ventilation. Heat stress can occur even when temperatures are moderate. The following actions will minimize the occurrence of heat stress:

- Provide plenty of liquids. To replace body fluids (water and electrolytes) lost due to sweating, use a 0.1 percent salt water solution, more heavily salted foods, or commercial mixes. The commercial mixes may be preferable for those employees on a low-sodium diet.
- Provide cooling devices, if necessary, to aid natural body ventilation. These devices, however, add weight, and their use should be balanced against worker efficiency.
- Long cotton underwear acts as a wick to help absorb moisture and protect the skin from direct contact with heat-absorbing protective clothing.
- In extremely hot weather, conduct non-emergency response operations in the early morning or evening.
- Ensure that adequate shelter is available to protect personnel against heat, cold, rain, snow, or other adverse weather conditions which decrease physical efficiency and increase the probability of accidents.
- In hot weather, rotate workers wearing protective clothing, and allow hourly work breaks to replace fluids and cool down.
- Good hygienic standards must be maintained by frequent change of clothing and daily showering. Clothing should be permitted to dry during rest periods. Workers who notice skin problems should consult medical personnel.

4.5.3.1 Effects of Heat Stress

If the body's physiological processes fail to maintain a normal body temperature because of excessive heat, a number of physical reactions can occur. They can range from mild reactions such as fatigue, irritability, anxiety, decreased concentration dexterity, or movement to death. Specific first aid treatment for mild cases of heat stress is provided in the American Red Cross first aid book. This book should be readily available for reference in the field. Medical assistance must be obtained for the more serious cases of heat stress.

4.5.3.2 Heat-Related Problems

Heat-related problems include:

- Heat rash: Caused by continuous exposure to heat and humid air and aggravated by chafing clothes. Decreases ability to tolerate heat as well as being a nuisance.
- Heat cramps: Caused by profuse perspiration with inadequate fluid intake and chemical replacement, especially salts. Signs include muscle spasm and pain in the extremities and abdomen.
- Heat exhaustion: Caused by increased stress on various organs to meet increased demands to cool the body. Signs include shallow breathing; pale, cool, moist skin; profuse sweating; and dizziness and lassitude.
- Heat stroke: The most severe form of heat stress. Body must be cooled immediately to prevent severe injury and/or death. Signs include red, hot, dry skin; no perspiration; nausea; dizziness and confusion; strong, rapid pulse; and possibly coma. Medical help must be obtained immediately.

4.5.3.3 Heat Stress Monitoring

Monitoring of personnel wearing impervious clothing will begin when the ambient temperature is 70°F or above. Table 4-4 presents the suggested frequency for such monitoring. Monitoring frequency will increase as the ambient temperature increases or as slow recovery rates are observed. Heat-stress monitoring will be performed by a person with a current first-aid certification, who is trained to recognize heat stress symptoms. For monitoring the body's recuperative abilities from excess heat, one or more of the techniques listed below will be used. Other methods for determining heat stress monitoring, such as the wet bulb globe temperature (WBGT) index from the American Conference of Governmental Industrial Hygienist (ACGIH) TLV Booklet may be used.

To monitor the worker, measure:

- Heart rate: Count the radial pulse during a 30-second period as early as possible during the rest period.
- If the heart rate exceeds 110 beats per minute at the beginning of the rest period, the next work cycle will be shortened by one-third and the rest period will remain the same.
- If the heart rate still exceeds 110 beats per minute at the next rest period, the following work cycle will be reduced by one third.
- Oral temperature: Use a clinical thermometer (3 minutes under the tongue) or similar device to measure the oral temperature at the end of the work period (before drinking).

- If oral temperature exceeds 99.6°F (37.6°C), the next work cycle will be reduced by one third without changing the rest period.
- If oral temperature still exceeds 99.6°F (37.6°C), at the beginning of the next rest period, the following cycle will be reduced by one third.

No worker will be permitted to wear a semi-permeable or impermeable garment when oral temperature exceeds 100.6°F (38.1°C).

Table 4-4

SUGGESTED FREQUENCY OF PHYSIOLOGICAL MONITORING FOR FIT AND ACCLIMATIZED WORKERS [a]

Adjusted Temperature [b]	Normal Work Ensemble [c]	Impermeable Ensemble
90°F or above (32°C)	After each 45 minutes of work	After each 15 minutes of work
87.5° - 90°F (30.8° - 32.2° C)	After each 60 minutes of work	After each 60 minutes of work
82.5° - 87.5°F (23.1° - 30.8°C)	After each 90 minutes of work	After each 90 minutes of work
77.5° - 82.5°F (25.3° - 28.1°C)	After each 120 minutes of work	After each 90 minutes of work
72.5° - 77.5°F (22.5° - 25.3°C)	After each 150 minutes of work	After each 120 minutes of work

a For work levels of 250 kilo calories/hr.

b Calculate the adjusted air temperature (ta adj) by using this equation: ta adj °F + (13 x % sunshine). Measure air temperature (ta) with a standard mercury-in-glass thermometer, with the bulb shielded from radiant heat. Estimate percent sunshine by judging what percent of time the sun is not covered by clouds that are thick enough to produce a shadow (100 percent sunshine - no cloud cover and a sharp, distinct shadow; 0 percent sunshine = no shadows).

c A normal work ensemble consists of cotton coveralls or other cotton clothing with long sleeves and trousers.

4.5.4 Cold Exposure

Persons working outdoors in temperatures at or below freezing may suffer from cold exposure. During prolonged outdoor periods with inadequate clothing, effects of cold exposure may even occur at temperatures well above freezing. Cold exposure may cause severe injury by freezing exposed body surfaces (frostbite) or result in profound generalized cooling, possibly causing death. Areas of the body that have high surface area-to-volume ratios, such as fingers, toes, and ears, are the most susceptible to frostbite.

Local injury resulting from cold is included in the generic term frostbite. There are several degrees of damage. Frostbite of the extremities can be categorized into:

- Frost nip or incipient frostbite: characterized by sudden blanching or whitening of skin.
- Superficial frostbite: skin has a waxy or white appearance and is firm to the touch, but tissue beneath is resilient.
- Deep frostbite: tissues are cold, pale, and solid; extremely serious injury.

Systematic hypothermia is caused by exposure to freezing or rapidly dropping temperature. Its symptoms are usually exhibited in five stages: (1) shivering; (2) apathy, listlessness, and (sometimes) rapid cooling of the body to less than 95°F; (3) unconsciousness, glassy stare, slow pulse, and slow respiratory rate; (4) freezing of the extremities; and (5) death.

4.5.5 Noise

Noise is defined as unwanted sound in the form of vibration conducted through liquids, solids, or gases. The effects of noise on humans includes psychological effects (interference with communication by speech, job performance, and safety) and physiological damage such as hearing loss. Of these, the most debilitating is hearing loss.

The factors that affect the degree and extent of hearing loss are intensity or loudness of the noise, type of noise, period of exposure each day, total work duration, and distance from the source. The Permissible Exposure Levels (PELs) for noise as measured in decibels (dBA) are provided below.

PELs for Noise

Duration (per day)	Measurement (dBA)
8 hours	90
6 hours	92
4 hours	95
3 hours	97
2 hours	100
1.5 hours	102

1 hour	105
30 minutes	110
15 minutes	115

Where 8-hour time-weighted averages are 85 dBA or greater, a hearing conservation program is required. This includes an initial audiogram to establish a baseline on the employee's hearing ability, followed by an annual audiogram to measure hearing. The conservation program should also allow employee access to their audiogram records.

OSHA 29 CFR 1910.95 stipulates that when employees are subject to sound that exceeds the PEL, feasible administrative or engineering controls shall be utilized. If controls fail to reduce sound exposure to within the PEL, personal protective equipment must be provided and used to decrease sound levels to within the PEL. Use of personal protective equipment (e.g., ear plugs or muffs) should be implemented immediately upon discovery of sound levels above the action level pending evaluation of suitable engineering controls. Exposure to impact noise should not exceed the 140 dBA peak sound level.

4.5.6 Control of Hazardous Energy (Lockout/Tagout)

The following action should be utilized whenever it is necessary to lockout or tagout the NWTS:

- Use only standard approved lockout/tagout devices. Lockout is preferred to tagout. The tag used in the tagout should contain the name of the person who attached it, the reason for doing so, and the date and time it was applied.
- Notify those working in the area of pending lockout.
- Shutoff the equipment. Remove the power source and securely attach lockout/tagout devices. De-energize the equipment. Test for effectiveness. Return controls to OFF position. Attach a tag identifying every person working in the lockout/tagout area.
- Do not remove anyone else's tag.
- Never bypass, ignore, or defeat a tag.
- Reverse the process when the job is complete.

SECTION 5

NITRITE WASTEWATER TREATMENT SYSTEM (NWTS) OPERATION AND MAINTENANCE

5.1 SAMPLE ANALYSIS

5.1.1 On-Site Water Quality Analyses

On-site water quality analyses are conducted using Hach Test Kits and direct reading instruments. Analytical parameters using Hach Test Kits are nitrite (NO_2^-), nitrate (NO_3^-), sulfate (SO_4^{-2}), and copper (Cu). On-site water quality data collected from direct reading instruments are pH and ORP. On-site sulfite (SO_3^{-2}) analysis is only performed during the first demonstration test because sulfite is found to be significantly interfered by the presence of nitrite in the wastewater.

Copper removal is selected as an indicator for heavy metals removal during the NWTS demonstration tests because previous pilot test results showed that copper is the most common heavy metal that exceeds discharge permit requirements for Navy boiler maintenance wastewater.

Instruments to be used for on-site water quality analyses are listed as follows:

Analyte	Analysis Instrument
Nitrate	Hach NI-12 / DR-2000
Nitrite	Hach NI-6 / DR-2000
Sulfate	Hach DR-2000
Sulfite	Hach SU-5 / DR-2000
Copper	Hach CU-6 / DR-2000
pH	Rosemount Model 54 Analyzer and Model 385+ Sensor (on the NWTS) and Hach pH Electrode and Meter (Portable)
ORP	Rosemount Model 54 Analyzer and Model 385+ Sensor (on the NWTS) and Hach pH Electrode and Meter (Portable)

5.1.2 Off-Site Water Quality Analyses

The samples collected during the demonstration tests are to be preserved with the appropriate reagents as shown in Table 5-1 and submitted to a state Certified laboratory to confirm the on-site analysis results. Parameters for off-site analyses included nitrate, nitrite, sulfate, sulfite, pH, total suspended solids (TSS) and metals. Metal analyses included cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), nickel (Ni), and zinc (Zn).

5.1.3 Sampling Schedule

Raw wastewater samples are collected for nitrite, nitrate, sulfate, sulfite, TSS, pH, and heavy metals analyses at the beginning of each test. During the nitrite reduction process, samples are collected periodically (at a typical time interval of 10-20 minutes) for residual nitrite analyses. Additional nitrite analyses are also performed at the point where the stoichiometric amount of sulfamic acid is added to the wastewater and the point that the metering pump is shutoff automatically by the NWTS control system.

During the metal precipitation process, samples are collected when no floc were observed in the reaction. On-site copper analyses are performed to evaluate the metal removal efficiency. Copper is selected as the indicator of metal removal because it is the most common metal that exceeds discharge permit requirements for Navy boiler maintenance wastewater.

After the pH neutralization process, samples are collected for on-site and laboratory analyses to confirm the water quality data before final disposal of the wastewater.

5.2 ORP/pH CONTROLLER CALIBRATION

For easier system operation, ORP and pH controllers are calibrated using portable ORP and pH meters before commencing the nitrite reduction-reaction process. The portable ORP and pH meters are calibrated using standard ORP and pH solutions. The calibrated ORP and pH portable meters were then used to measure the wastewater ORP and pH. Measured ORP and pH values were used as the target values for the NWTS controllers calibration. During the demonstration test, portable meters were periodically used to measure the wastewater ORP and pH. Results were used to verify the readings obtained from the NWTS controllers.

5.3 CHEMICAL PREPARATION

Chemicals required for the NWTS are sulfuric acid, sodium hydroxide, sulfamic acid, and anionic polymer with concentrations of 10%, 20%, 10%, and 0.2%, respectively. These chemicals in the recommended concentrations are commercially

TABLE 5-1

SAMPLE ANALYTICAL PRESERVATION PROCEDURES, AND REQUIREMENTS

Parameter	Method	Procedures	Requirement
Nitrate - N Nitrite - N	Store at 4 degrees C; Plastic or Glass Container	EPA 352.1 EPA 354.1 and per section 6.10.7	Start nitrate or nitrite analyses within 48 hours after sampling
Sulfate-S Sulfite-S	Store at 4 degrees C; Plastic or Glass Container	EPA 375.4 EPA 377.1 and per Section 6.10.7	Analyze sulfite immediately, and start sulfate analyses within 7 days after sampling
Cadmium*	add 1.5 mL conc. nitric acid per liter sample; store at 4 degrees C; Plastic or Glass Container	EPA 213.1 and per section 6.10.7	acidify samples immediately after sampling; acidify samples to pH <2, holding time 6 mos.
Chromium*	add 1.5 mL conc. nitric acid per liter sample; store at 4 degrees C; Plastic or Glass Container	EPA 218.1 and per section 6.10.7	acidify samples immediately after sampling; acidify samples to pH <2, holding time 6 mos.
Copper*	add 1.5 mL conc. nitric acid per liter sample; store at 4 degrees C; Plastic or Glass Container	EPA 220.1 and per section 6.10.7	acidify samples immediately after sampling; acidify samples to pH <2, holding time 6 mos.
Iron*	add 1.5 mL conc. nitric acid per liter sample; store at 4 degrees C; Plastic or Glass Container	EPA 236.1 and per section 6.10.7	acidify samples immediately after sampling; acidify samples to pH <2, holding time 6 mos.
Lead*	add 1.5 mL conc. nitric acid per liter sample; store at 4 degrees C; Plastic or Glass Container	EPA 239.1 and per section 6.10.7	acidify samples immediately after sampling; acidify samples to pH <2, holding time 6 mos.
Nickel*	add 1.5 mL conc. nitric acid per liter sample; store at 4 degrees C; Plastic or Glass Container	EPA 249.1 and per section 6.10.7	acidify samples immediately after sampling; acidify samples to pH <2, holding time 6 mos.
Zinc*	add 3 mL conc. sulfuric acid, store at 4 degrees C; Glass Container	EPA 418.1 and per section 6.10.7	holding time 28 days
pH	store at 4 degrees C; Plastic or Glass Container	EPA 150.1 and per section 6.10.7	analyze immediately
TSS	store at 4 degrees C; Plastic or Glass Container	EPA 160.2 and per section 6.10.7	analysis samples within 7 days after sampling

* A 1 liter sample can be collected for all metals analyses.

available in 55 gallon drums. The sulfamic acid can also be bought in 50 lb bags of powder. The operator needs to transfer chemicals from these drums to the trailer-mounted containers with a hand pump. If the base wishes to prepare chemical solutions from concentrated stock chemicals, the base safety officer must be advised and additional procedures established.

CAUTION: NEVER FILL THE TRAILER-MOUNTED CONTAINERS TO A LEVEL ABOVE THE CONTAINER SHOULDER.

5.3.1 Sulfuric Acid

Transfer sulfuric acid from a 55 gallon storage drum to the 5.5 gallon container designed for the treatment unit using a hand pump.

CAUTIONS: Sulfuric acid is a strong acid that can burn clothing, skin, and eyes. Prevent skin and eye exposure by wearing appropriate protective clothing, including splash-proof full-face safety shield, safety shoes, splash-proof apron, and protective gloves. If skin or eye contact occurs, flush with potable water for 15 minutes, inform the supervisor, and obtain immediate medical attention. If the operator needs to dilute sulfuric acid, NEVER ADD WATER TO CONCENTRATED SULFURIC ACID. Always dilute the sulfuric acid by slowly adding sulfuric acid to water. Note that the addition of sulfuric acid to water can produce a significant amount of heat. Monitor acid dilution and ensure that excess heat does not build up in the container.

Cap the container immediately after sulfuric acid has been transferred.

5.3.2 Sulfamic Acid

Transfer sulfamic acid from a 55 gallon storage drum to the 13 gallon container designed for the treatment unit using a hand pump. If using sulfamic powder fill the container on the unit with 13 gallons of water. Slowly add 12 pounds of sulfamic powder to the water. Mix the solution well. Ensure you wear proper protective clothing when mixing the powder.

CAUTION: Sulfamic acid is a strong acid that can burn skin and eyes. Prevent skin and eye exposure by wearing appropriate protective clothing, including splash-proof full-face safety shield, safety shoes, splash-proof apron, and

protective gloves. If skin or eye contact occurs, flush with potable water for 15 minutes, inform the supervisor, and obtain immediate medical attention.

Cap the container immediately after sulfamic acid has been transferred.

5.3.3 Sodium Hydroxide

Transfer sodium hydroxide from a 55 gallon drum to the 5.5 gallon container designed for the treatment unit using a hand pump.

CAUTION: Sodium hydroxide is a strong base that can burn skin and eyes. Prevent skin and eye exposure by wearing appropriate protective clothing, including splash-proof full-face safety shield, safety shoes, splash-proof apron, and protective gloves. If skin or eye contact occurs, flush with potable water for 15 minutes, inform the supervisor, and obtain immediate medical attention. If the operator needs to dilute sodium hydroxide solution, monitor the dilution process and ensure that excess heat does not build up in the container. Note that addition of water to sodium hydroxide produces a significant amount of heat.

Cap the container immediately after sodium hydroxide has been transferred.

5.3.4 Polymer

Transfer polymer solution from a 55 gallon storage drum to the 5.5 gallon container designed for the treatment unit using a pump. Polymer may irritate or burn skin and eyes. Wear protective clothing, gloves and goggles. Cap the container immediately after the polymer has been transferred. Spilled polymer should be cleaned up immediately as it is a slip hazard.

5.4 POWER CONNECTION

5.4.1 Main Power Connection

The power source for the NWTS is 480 Volt and 3 phase and the full load amperage is 30 amps. Note that the control panel also uses 110 volt, single phase power. This is accomplished by converting the 480 volt, 3 phase power to 110 volt, single phase power through a transformer located next to the trailer mounted unit control panel. A connector on the exterior of the electrical safety switch box is provided to connect power from the source to the NWTS. The operator should wear approved electrical protective

gloves to perform the connection. Minimum standard for the gloves shall be ASTM D-120, Type I, Class 0.

5.5 OPERATIONS PROCEDURES

5.5.1 System Operation

Operation procedures are provided as follows:

Transfer chemicals into the appropriate containers as described in Section 5-3. Place containers on the trailer in their proper locations. Remove chemical container caps and insert proper metering pump suction tubes into their containers.

Pump wastewater from the Waterjet Wastewater Recycling Unit to the reaction tank on the NWTS. This can be accomplished by using the RECIRCULATING pump on the treatment unit or an external pump. The procedures for transferring wastewater to the NWTS are described below for the two options. Note that a female quick disconnect coupler should be provided on the tank of Waterjet Wastewater Recycling Unit drain valve to use the recirculating pump alternative. Stop the pump when the water level in the reaction tank reaches the desired level. Caution must be taken not to overfill the reaction tank or to run the pump dry. The filling cycle will take approximate 12 to 20 minutes to completely fill the reaction tank.

If using the RECIRCULATING pump, the following procedures should be used (refer to P&ID drawing in section 3 for valve/piping designations):

a) Remove the filters, if installed from the NWTS.

b) Ensure valves BV-100B, BV-100C, BV-101G and BV-101H are closed.

c) Connect hose to quick disconnect fitting at valve BV-100A.

d) Verify that valves BV-100A, BV-101A, BV-101B, BV-101C, BV-101D, BV-101E and BV-101F are open.

e) Turn on the pump. The filling process takes approximately 12 to 20 minutes.

f) Turn off the pump when the water level in the reaction tank reaches the desired level.

g) Close valve BV-100A.

If using the an external pump the following procedure should be used:

a) Remove the filters, if installed, from the NWTS.

b) Ensure valves BV-100A, BV-100B, BV-101G and BV-101H are closed.

c) Connect the external pump to the quick disconnect fitting at ball valve BV-100C.

d) Verify that valves BV-100C, BV-101A, BV-101B, BV-101C, BV-101D, BV-101E and BV-101F are open.

e) Turn on the pump. Turn off the pump when the water level in the reaction tank reaches the desired level.

f) Close valve BV-100C.

Note: If there is an air operated pump available, the operator should try to use the air operated pump (instead of using the pump on the trailer) for transferring of the wastewater.

Start the mixer, see Figure 5-1. Adjust mixer speed to approximately 65 percent of the speed position button. Verify valves BV-100B, BV-101A and BV-101C (or BV-101B and BV-101D), BV-101E, and BV-101H are open. Start the recirculating pump (P-100).

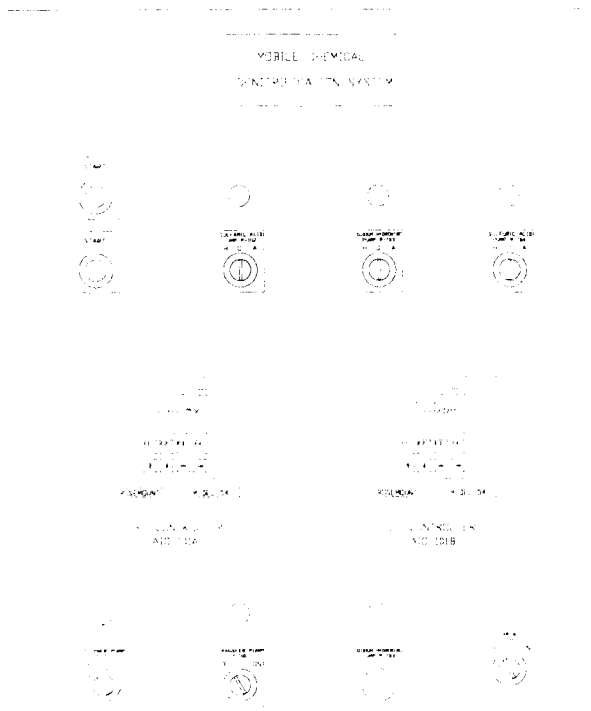


Figure 5-1 NWTS Control Panel

Verify that valves BV-102A, BV-102B, BV-103A, BV-103B, BV-104A, BV-104B, BV-105A AND BV-105B are opened, then turn the sulfamic acid metering pump control switch, sulfuric acid metering pump control switch, polymer pump control switch and the sodium hydroxide metering pump control switch to "auto" position, see Figure 5-1. Push the PLC start button. Computer software stored in the PLC will execute and monitor pH and ORP changes. Once changes of the pH and ORP reach the pre-set point in the PLC program, the PLC will send a control signal to the sulfamic acid metering pump for shutoff. See Figure 3-4 for PLC control logic. Monitor ORP reading every 30 minutes. Required time to reach the end of the nitrite reduction reaction is approximately 1-2 hours. When the nitrite reduction (sulfamic acid addition) process is complete, use the Hach nitrite test kits (Hach Cat. 1468-03 for nitrate and Hach Cat. 20596-00 for nitrite or DR-2000 for nitrate and nitrite) to confirm treatment results.

The PLC will automatically go into the metal precipitation phase and adjust the pH to 11.0 and inject the polymer. The system will filter out the heavy metal particles for approximately 1 hour.

The PLC will adjust the pH after the metal precipitation phase to between 6 and 8. If the pH is not in this range after completion of this phase it can be raised and lowered by the addition of sodium hydroxide or sulfuric acid respectively.

Discharge treated wastewater per permit requirements. Close valves BV-101C, BV-101D, BV-101E, and BV-101F to keep water in the sensor lines. This will protect the pH sensor and ORP sensor from drying.

5.5.2 Filter Media Replacement and Disposal

Used filter cartridges may contain toxic heavy metals such as cadmium, chromium, copper, iron, lead, nickel, and zinc. The used filter cartridges should be considered a hazardous waste. Cartridges removed from the filters should be handled in accordance with all Federal regulations and local codes and requirements for hazardous waste disposal. The operators should wear protective clothing while replacing the filter cartridges.

5.5.3 Spill Handling

5.5.3.1 Small Spill

If the volume of spilled wastewater is less than 1 gallon, the operator should clean up the spill with neutralizing agents or absorbent materials. If a small amount of chemicals are spilled, use commercially available acid or caustic clean up kits. Because chemicals used for this system are extremely corrosive, wash down the area with water and detergent after the spill is cleaned up. All clean-up materials should be disposed of as hazardous waste.

5.5.3.2 Large Spill

If more than 1 gallon of chemicals or wastewater are spilled, the operator should:

a) Immediately shut down the system (if operating)

b) Notify the Base spill response team.

c) Contain the spill and cordon off the spill area.

5.5.4 Sampling

Samples should be collected through the sample tap located at the effluent discharge side of the filters. Flush the sample tap with about 50 ml before sample

collection. Recycle flush water and excess sample back to the reaction tank. All samples should be stored in a appropriate containers and should be properly preserved for the intended analyses. A matrix of recommended analytical methods, sample procedures, and requirements is given in Table 5-1.

5.5.5 Unused Chemicals

Unused chemicals should be handled appropriately. Unused chemicals and chemicals used in testing water (i.e. Hach test wastes) should be transferred to hazardous waste drums and disposed properly. The drums should meet DOT regulations requirements. Disposal of unused chemicals should meet all Federal regulations, local codes and requirements for disposal of corrosive materials.

5.5.6 Records

Keeping good records of process performance is an essential part of an operator's job. Records are used for controlling unit processes by interpreting operational data and laboratory test results. Records will serve as a check on your visual observations and judgment to refine the accuracy and dependability of your process operations. Records will also be used for planning and implementing preventative maintenance.

How Records Should Be Kept. Records must be permanent, complete, and accurate. Record entries on data sheets in ink. Lab analyses of treated water quality should be maintained indefinitely. Keep records neat and organized. Maintain records in a labeled ring binder and store it in an appropriate place.

5.5.6.1 Maintenance Records

Maintenance records should help the operator plan for the proper upkeep of the equipment on the trailer mounted unit. These records may be kept on individual sheets or cards for each piece of equipment, showing the schedule for periodic lubrication, inspection, cleaning, replacement, calibration, and other relevant data.

5.5.6.2 Operating Records

The operator should record data which reflects the treatment process of the unit. A recommended format for operating records is presented in Table 5-2. When data are not recorded, put a dash in the space to indicate that data were not overlooked.

TABLE 5-2

RECOMMENDED OPERATION DATA/SAMPLING SCHEDULE

Date/Time:							
Wastewater Source:							
Treatment Location:							
Wastewater Volume (gal)							
Sulfamic Acid (10%) Volume				Initial:	gal	Final:	gal
ORP Set Point (mV)							
Mixer Speed							
Sampling @	(1)	Temp	pH	ORP	Nitrite	Nitrate	Copper
	t = 0 min. t = 30 min. t = 60 min. t = 90 min. t = 120 min. t = 150 min. t = 180 min. t = 210 min. t = 240 min. t = 270 min.						
pH set Point for NaOH							
Sodium Hydroxide (25%) Volume				Initial:	gal	Final:	gal
Polymer (0.2%) Volume				Initial:	gal	Final:	gal
Mixer Speed after polymer							
Sample for TSS (off-site analysis)							
No. of Filter Changes							
Max. Pressure Drop (psi)							
Recirculation Flow Rate (gpm)							
Sampling @	Copper Conc. No. 1 Copper Conc. No. 2 Copper Conc. No. 3						
pH Set Point for H_2SO_4							
Sulfuric Acid (10%) Volume				Initial:	mL	Final:	mL
Final Collected Sample (2)				Nitrite	Nitrate	Copper	pH
Discharge Location							
(1) Full matrix analyses (as shown on Table 5-1) for laboratory at t = 0. (2) Sample shall be collected for full matrix analyses for outside laboratory.							

5.6 TROUBLESHOOTING GUIDE

The following troubleshooting guide is presented to provide the operator with possible causes and recommended actions for diagnosing and correcting system malfunctions.

Symptom	Possible Cause	Corrective Action
Power supply does not come on	Poor connection to power source or circuit breaker open	Reconnect to power source or reset circuit breaker
Recirculating pump does not start	Circuit breaker open or poor contact	Reset circuit breaker or check wiring system
Recirculating pump does not start	Pump head reaches shutoff	Inspect valves to ensure valves are properly open; check and replace filter cartridges
Pressure gage reads incorrectly	Damaged Gauge	Replace the gauge
Can't reset ORP controller	Improper operation or damaged controller	Check manufacturer's instruction manual or call manufacturer's rep.
Observed pH in treated water higher than lab. results	pH controller not calibrated	Calibrate pH sensor and controller per manufacturer's instruction manual
Can't reset pH controller	Improper operation or damaged controller	Check manufacturer's instruction manual or call manufacturer's rep.
Mixer does not start	Fuse in speed controller blown	Replace fuse in controller
Can't adjust mixer speed	Controller damaged	Check manufacturer's instruction manual or call manufacturer's rep.
High heavy metals concentration in effluent	Inappropriate flocculation pH; wastewater chemistry changed; failed filters	Check pH sensor and controller; analyze wastewater chemistry; replace filter cartridges
Can't pump chemical into reaction tank	Low liquid levels in chemical containers or broken pumps	Refill chemicals and inspect pumps per manufacturer's instruction manual

5.7 MAINTENANCE

Good maintenance does not "just happen", it is the result of knowledge of what to do. It is planning and carrying out a program designed to minimize equipment breakdowns. It is preparing in advance for replacement of worn-out parts. It is having knowledge and equipment ready to take care of emergencies. A maintenance program should include:

- Regular maintenance program (lubrication, visual inspection, calibrations, adjustments, and corrections before failure).
- Keeping records and schedules.
- Having sufficient parts and tools on hand.
- Good operation (prevent damage through proper use).
- Remedial maintenance program (timely correction of damage).

5.7.1 Regular Maintenance

Use a system to keep the regular maintenance program running. The system must first signal when a maintenance task must be done. It must instruct the maintenance persons of what is to be done. It must have a means of recording what was done. A recommended maintenance service procedure is presented in Table 5-3. The operator should perform maintenance work on pumps, tank, mixer, containers, and instruments as recommended by manufacturers. The operator should also check tank, pipes, valves, hoses, and tubing's for leaks and deterioration before starting up the system. All instruments should be calibrated on a regular basis. Weekly calibrations are recommended. CAUTION: NEVER STORE THE pH SENSOR AND ORP SENSOR IN DRY CONDITIONS. During long periods (more than one month) of not use, remove the pH sensor and ORP sensor from the trailer mounted unit. Use moisture caps on these sensors to prevent drying.

5.8 LOGISTICS SUPPORT

The necessary consumables and spare parts for the prototype NWTS are listed as follows:

Item	Required Quantity
Sulfuric Acid (10%)	min. 10 gallons
Sodium Hydroxide (20%)	min. 10 gallons
Sulfamic Acid (10%)	min. 30 gallons
Anionic Polymer	min. 10 gallons
Hach Nitrate Reagent Pillows	min. 25 pillows
Hach Nitrite Reagent Pillows	min. 25 pillows
Hach Copper Reagent Pillows	min. 25 pillows
pH = 7.0 Standard Solution	200 mL
pH = 10.0 Standard Solution	200 mL
Safety Gloves	10 pairs
Safety Apron	10

Full-Face Safety Shield	2
Safety Glasses	5
Beakers	5
Disposable Pipettes	as needed
Sample Bottles - 200 mL	10
ORP Sensor	1
pH Sensor	1
Pumps/Mixer Lubricated Oils	as needed
Paper Towels	as needed

TABLE 5-3

RECOMMENDED EQUIPMENT MAINTENANCE SERVICE PROCEDURE

Item		Service Procedure	Suggested Inspection
Motors:			
	Voltage	Check input voltage, compare with rating plate data (+/- 10% variation acceptable)	Annually
	Frequency	Check frequency to ensure variation does not exceed 5% above or below normal	Annually
	Overload	Check for overheating if sustained overload occurred	As required
	Temperature	Measure temperature to ensure unit is within guaranteed limits	Quarterly
	Lubrication data	Method of application. Types of grease for adverse conditions. Maintenance cycle by locations. Record data for each rotor. Check manufacturers recommendation for proper lubrication cycle and lubricant.	Quarterly
	Cleaning	Dust, vacuum, clean open motors, disassemble and clean with manufacturer recommended solvent.	Annually
Motor trouble:			
	Excessive hum	Check input voltage. Investigate rotor balance	As required
	Regular clicking	Remove foreign matter from rotor	As required
	Rapid knocking	Replace bearing, change grease	As required
	Vibration	Rotor needs balancing	As required
	Overheating	Check connections. Insufficient lubricant	As required
Valves:			
	Check	Inspect disc facing. Repair seat if scarred or replace the valve	Annually
	Ball	Replace the valve if leaks observed	As required
Sensor:			
	pH	Cleaning per manufacturer recommendation. Replace the sensor if the sensor has failed.	Quarterly
	ORP	Cleaning per manufacturer recommendation. Replace the sensor if the sensor has failed.	Quarterly
Analyzer:			
	pH	Perform diagnostics check per manufacturer's instruction manual	As required
	ORP	Perform diagnostics check per manufacturer's instruction manual	As required

SECTION 6

ECONOMIC ANALYSIS

The economic analysis was performed to estimate the capital investment cost and the operating costs based on the recommended "improved NWTS" and operation information collected during the NWTS demonstration tests.

The cost estimating concluded that the treatment cost for using the NWTS to treat boiler maintenance wastewater is approximately $0.14 per gallon for the facility such as Navy SIMA San Diego. This estimated treatment cost is much lower than current nitrite wastewater treatment cost ($2.25/gal) reported in the same report.

Estimated capital cost and operations and maintenance (O&M) costs are presented in Tables 6-1 and 6-2, respectively.

The assumptions and conditions for the economic analysis are as follows:

Capital Cost

Material costs were provided directly from the manufacturers and the contractor who assumed the current NWTS. Details of equipment specifications are presented in Section 3.

Operations and Maintenance Costs

Chemical costs were provided directly from the chemical supplier. A 40 percent discount was already included to accommodate purchasing a large quantity of chemicals will be used annually in full scale operation of the NWTS.

Electrical cost was assumed to be $0.09 per kwh.

Sampling costs were developed by assuming that on-site laboratory sample analyses will be required for each batch using Hach test kits.

Waste disposal costs were estimated for the off-site disposal of used filter cartridges. Each batch operation of the NWTS would need to dispose of 3 filter cartridges.

Table 6-1

NWTS CAPITAL COST ESTIMATE

CAPITAL COSTS	Unit Price	No. of Units	Total Price
Equipment			
Trailer	$3,000	1	$3,000
Metering Pumps	$1,100	4	$4,400
Metering Pump Controllers	$100	4	$400
Recirculation Pump	$850	1	$850
Mixer	$800	1	$800
Reactor	$800	1	$800
Filters	$70	7	$490
Hand Pump	$60	1	$60
Chemical Containers	$50	4	$200
PLC	$3,500	1	$3,500
pH Sensor/Controller	$2,000	1	$2,000
ORP Sensor/Controller	$2,000	1	$2,000
Miscellaneous			
Electrical	Lump Sum	-	$4,000
Piping	Lump Sum	-	$1,500
PLC Program	Lump Sum	-	$2,000
Chemical Containment	$1,000	1	$1,000
Total Construction Cost			$27,000
Contractor's Profit			$4,000
TOTAL CAPITAL COSTS			$31,000

Table 6-2

NWTS OPERATION AND MAINTENANCE COSTS ESTIMATE

Items	Required Quantity Per Batch	Unit Price	Total Price ($/Batch)
Chemicals			
10% Sulfamic Acid	10 gal	$0.50 /gal	$5.00
20% Sodium Hydroxide	2.5 gal	$5.20 /gal	$13.00
0.2% Polyacrylamide	1.5 gal	$9.50 /gal	$14.25
10% Sulfuric Acid	2 gal	$8.50 /gal	$17.00
Power	4 kwh	$0.09 /kwh	$1.00
Sampling			
Nitrite	2 (average)	$.19	$0.38
Nitrate	1 (average)	$.21	$0.21
Heavy Metals	1 (average)	$4.42	$0.21
TSS	1 (average)	$.10	$0.10
Waste Disposal	6 lb	$2.50 /lb	$15
Total O&M Costs per Batch Wastewater			**$66**

Treatment Capacity Per Batch **500 gal/batch**

O&M Costs Per Gallon Wastewater **$0.14 /gal**

(1) Assumed monthly off-site sample analyses will be performed per permit requirements. Number of sample analyses per batch are calculated based on monthly average values.

SECTION 7

REFERENCES

1. "Initial Feasibility Study on Treatment of Sodium Nitrite Wastewater from Naval Shipyards." by B. Y. K. Pan and A. L. Law, Naval Civil Engineering Laboratory NCEL Technical Memorandum TM-71-90-4, May 1990.

2. "Final Feasibility Report on Chemical Treatment of Sodium Nitrite Wastewater." by T. R. Lee, B. Pan, and H. Sheng, Naval Civil Engineering Laboratory NCEL Technical Note, TN-1841, March 1992.

3. "Pilot Nitrite Reduction/Metal Precipitation System to Treat Sodium Nitrite Wastewater." Contractor Report by Arthur D. Little, Inc., December 1992